

APPENDIX B

TEST 25 - WATER CALIBRATION

B-1

TEST 25				SET 1		microvolts			
1	0	9	26	17	-7	25	-4032	33	1
2	18	10	61	18	41	26	19	34	-12
3	41	11	35	19	15	27	46	35	28
4	28	12	15	20	22	28	27	36	63
5	44	13	-1433	21	37	29	25	37	102
6	73	14	21	22	37	30	0	38	-93
7	42	15	35	23	29	31	24		
8	-59	16	31	24	28	32	30		

TEST 25			SET 2			microvolts			
1	0	9	26	17	38	25	-4031	33	12
2	18	10	60	18	107	26	19	34	17
3	39	11	34	19	31	27	44	35	70
4	27	12	14	20	7	28	27	36	118
5	43	13	-1428	21	29	29	26	37	112
6	74	14	22	22	30	30	0	38	-9
7	40	15	64	23	31	31	26		
8	-58	16	71	24	27	32	33		

Surface Heights mm

0 0 -182 182 182 182 -182 0 0

TEST 25			SET 3			microvolts		
1	0	9	17	87	25	-4035	33	57
2	19	10	58	18	159	26	20	61
3	40	11	51	19	66	27	44	35
4	28	12	56	20	22	28	29	117
5	43	13	-1415	21	38	29	35	160
6	73	14	69	22	37	30	33	37
7	33	15	127	23	30	31	33	149
8	-58	16	115	24	28	32	34	117

Surface Heights mm

0 0 -297 297 297 297 -297 0 0

TEST 25			SET 4			microvolts		
1	0	9	67	17	133	25	-4037	33 93
2	18	10	113	16	204	26	33	34 104
3	39	11	96	19	92	27	68	35 156
4	27	12	105	20	22	28	55	36 201
5	43	13	-1410	21	36	29	79	37 175
6	76	14	111	22	37	30	57	38 284
7	33	15	184	23	30	31	61	
8	-47	16	157	24	30	32	128	

Surface Heights mm

0 -404 404 404 404 404 404 -404 0

TEST 25			SET 5			microvolts		
1	0	9	103	17	172	25	-4025	33 128
2	19	10	154	18	244	26	62	34 144
3	41	11	139	19	108	27	99	35 188
4	42	12	149	20	23	28	78	36 235
5	72	13	-1408	21	38	29	116	37 193
6	126	14	149	22	46	30	87	38 472
7	37	15	235	23	53	31	70	
8	-15	16	193	24	65	32	169	

Surface Heights mm

0 -498 498 498 498 498 498 -498 0

TEST 25			SET 6			microvolts		
1	0	9	136	17	204	25	-4011	33 156
2	26	10	189	18	276	26	86	34 176
3	62	11	173	19	120	27	123	35 216
4	85	12	185	20	30	28	99	36 265
5	98	13	-1406	21	59	29	145	37 207
6	162	14	179	22	78	30	112	38 688
7	46	15	275	23	83	31	64	
8	16	16	222	24	103	32	205	

Surface Heights mm

0 -574 574 574 574 574 574 -574 0

TEST 25 SET 2

Weight= 92.7 N Volume= 10.1 Litres
 Density= 937.0 Kg/M³ Weight Factor= 1.000

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	23.1	-5.6 Pa	2.4 Pa
-47.3	-25.2	0.00 Deg	0.00 Deg
-18.9	21.8		
-20.0	45.9		
21.8	-21.1		
23.8	0.0	12.4 Pa	5.1 Pa
0.0	-55.9	0.00 Deg	0.00 Deg
-24.0	0.0		
-25.4	25.5		
-28.6	0.0		
27.4	67.5	42.1 Pa	25.1 Pa
546.4	303.1	0.00 Deg	0.00 Deg
1030.8	700.6		
1209.2	1096.6		
1805.8	1521.9		

TEST 25 SET 3

Weight= 231.6 N Volume= 23.9 Litres
 Density= 988.8 Kg/M³ Weight Factor= 1.000

Normal Stress(Pa)		Shear Stress/Friction Angle	
23.4	0.0	-25.0 Pa	-7.2 Pa
-23.7	-25.2	0.00 Deg	0.00 Deg
0.0	0.0		
-20.0	23.0		
0.0	0.0		
23.8	33.4	44.6 Pa	22.9 Pa
0.0	-55.9	0.00 Deg	0.00 Deg
168.1	71.3		
406.6	254.5		
1170.6	658.3		
1313.3	1214.5	134.1 Pa	118.0 Pa
1733.3	1542.8	0.00 Deg	0.00 Deg
2164.7	1763.7		
2525.8	2323.8		
3226.5	2684.0		

TEST 25 SET 4

Weight= 415.8 N Volume= 43.4 Litres
 Density= 975.8 Kg/M³ Weight Factor= 1.000

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	0.0	-25.0 Pa	-12.1 Pa
-47.3	-25.2	0.00 Deg	0.00 Deg
-18.9	0.0		
-20.0	23.0		
65.4	42.2		
285.4	467.3	57.0 Pa	94.0 Pa
950.0	514.9	0.00 Deg	0.00 Deg
1249.0	997.6		
1550.0	1374.3		
2569.5	1631.3		
2462.4	2204.0	202.5 Pa	183.2 Pa
2807.2	2534.6	0.00 Deg	0.00 Deg
3247.0	2802.6		
3761.8	3342.1		
4459.7	3818.5		

TEST 25 SET 5

Weight= 523.2 N Volume= 62.2 Litres
 Density= 1020.7 Kg/M³ Weight Factor= 1.000

Normal Stress(Pa)		Shear Stress/Friction Angle	
23.1	23.1	-13.9 Pa	16.9 Pa
25.2	25.2	0.00 Deg	0.00 Deg
196.6	196.6		
551.3	551.3		
780.7	780.7		
1046.3	1435.3	62.0 Pa	116.8 Pa
1784.1	1481.3	0.00 Deg	0.00 Deg
2233.9	1817.1		
2642.6	2315.9		
3825.7	2489.9		
3502.1	3126.1	244.6 Pa	228.4 Pa
3758.0	3498.9	0.00 Deg	0.00 Deg
4174.7	3769.0		
4809.7	4177.6		
5554.1	4759.2		

APPENDIX C1

RAW DATA - BIN 1

C1-1

TEST 20				SET 1		microvolts			
1	0	9	12	17	28	25	-3980	33	2
2	1	10	14	18	8	26	-12	34	-29
3	7	11	6	19	34	27	0	35	2
4	3	12	-16	20	-5	28	-4	36	27
5	4	13	-1389	21	13	29	-11	37	114
6	32	14	8	22	14	30	-14	38	-39
7	59	15	-2	23	0	31	34		
8	26	16	5	24	1	32	16		

TEST 20				SET 2		microvolts			
1	0	9	10	17	100	25	-3977	33	43
2	0	10	13	18	75	26	-10	34	31
3	6	11	6	19	181	27	0	35	71
4	4	12	-16	20	-4	28	-3	36	90
5	4	13	-1380	21	13	29	-10	37	283
6	33	14	24	22	14	30	-14	38	176
7	61	15	60	23	-1	31	39		
8	25	16	71	24	0	32	29		

Surface Heights mm

0 0 -200 210 260 210 -200 0 0

TEST 20				SET 3		microvolts			
1	0	9	62	17	173	25	-3954	33	133
2	1	10	87	18	127	26	5	34	108
3	6	11	98	19	453	27	47	35	133
4	4	12	100	20	-4	28	48	36	138
5	3	13	-1140	21	13	29	72	37	596
6	32	14	130	22	15	30	73	38	715
7	58	15	173	23	0	31	279		
8	42	16	141	24	0	32	131		

Surface Heights mm

0 -385 405 465 525 470 410 -390 0

CI-1

TEST 20 SET 1 microvolts									
1	0	9	12	17	28	25	-3980	33	2
2	1	10	14	18	8	26	-12	34	-29
3	7	11	6	19	34	27	0	35	2
4	3	12	-16	20	-5	28	-4	36	27
5	4	13	-1389	21	13	29	-11	37	114
6	32	14	8	22	14	30	-14	38	-39
7	59	15	-2	23	0	31	34		
8	26	16	5	24	1	32	16		

TEST 20 SET 2 microvolts									
1	0	9	10	17	100	25	-3977	33	43
2	0	10	13	18	75	26	-10	34	31
3	6	11	6	19	181	27	0	35	71
4	4	12	-16	20	-4	28	-3	36	90
5	4	13	-1380	21	13	29	-10	37	283
6	33	14	24	22	14	30	-14	38	176
7	61	15	60	23	-1	31	39		
8	25	16	71	24	0	32			

Surface Heights mm

0 0 -200 210 260 210 -200 0

TEST 20 SET 3 microvolts									
1	0	9	52	17	173	25	-3954	33	133
2	1	10	87	18	127	26	5	34	108
3	6	11	98	19	453	27	47	35	133
4	4	12	100	20	-4	28	48	36	138
5	3	13	-1140	21	13	29	72	37	596
6	32	14	130	22	15	30	73	38	715
7	58	15	173	23	0	31	279		
8	42	16	141	24	0	32	131		

Surface Heights mm

0 -385 405 465 525 470 410 -390 0

C1-2

			TEST 20		SET 4		microvolts		
1	0	9	160	17	225	25	-3740	33	192
2	20	10	181	18	170	26	87	34	159
3	51	11	185	19	621	27	136	35	180
4	106	12	177	20	12	28	103	36	176
5	104	13	-793	21	60	29	146	37	796
6	181	14	201	22	105	30	133	38	1580
7	303	15	241	23	107	31	619		
8	163	16	193	24	145	32	214		

Surface Heights mm

-570 600 660 720 780 725 660 605 -570

			TEST 20		SET 5		microvolts		
1	0	9	215	17	106	25	-3699	33	189
2	14	10	242	18	58	26	124	34	55
3	63	11	229	19	460	27	183	35	68
4	136	12	231	20	10	28	138	36	70
5	132	13	-655	21	69	29	199	37	604
6	227	14	181	22	124	30	168	38	1563
7	352	15	190	23	134	31	768		
8	205	16	107	24	188	32	173		

Surface Heights mm

-570 600 660 710 770 710 660 605 -570

			TEST 20		SET 6		microvolts		
1	0	9	226	17	122	25	-3700	33	138
2	9	10	244	18	61	26	122	34	60
3	62	11	229	19	419	27	191	35	65
4	143	12	202	20	9	28	152	36	71
5	139	13	-658	21	72	29	211	37	558
6	240	14	188	22	128	30	133	38	1483
7	353	15	185	23	139	31	752		
8	220	16	101	24	195	32	188		

Surface Heights mm

-570 600 660 710 770 710 660 605 -570

C1-3

TEST 20			SET 7			microvolts		
1	0	9	235	17	121	25	-3700	33 108
2	8	10	236	18	63	26	122	34 69
3	32	11	224	19	410	27	175	35 64
4	119	12	183	20	7	28	122	36 72
5	122	13	-708	21	47	29	165	37 534
6	210	14	168	22	97	30	162	38 1452
7	355	15	178	23	114	31	735	
8	204	16	101	24	154	32	192	

Surface Heights mm

-570 600 645 665 700 665 645 605 -570

TEST 20			SET 8			microvolts		
1	0	9	211	17	125	25	-3767	33 131
2	5	10	214	18	62	26	101	34 66
3	30	11	167	19	398	27	171	35 72
4	64	12	196	20	4	28	128	36 71
5	48	13	-747	21	38	29	157	37 519
6	174	14	162	22	55	30	130	38 1265
7	296	15	187	23	60	31	681	
8	175	16	102	24	115	32	168	

Surface Heights mm

-570 590 610 590 600 590 610 600 -570

TEST 20			SET 9			microvolts		
1	0	9	172	17	111	25	-3846	33 128
2	-9	10	207	18	58	26	95	34 67
3	14	11	220	19	391	27	125	35 67
4	44	12	147	20	-4	28	123	36 68
5	29	13	-831	21	30	29	158	37 505
6	104	14	159	22	49	30	82	38 1062
7	195	15	170	23	34	31	595	
8	75	16	108	24	84	32	152	

Surface Heights mm

-570 550 570 540 500 540 560 570 -570

C1-4

TEST 20			SET 10			microvolts			
1	0	9	37	17	104	25	-3952	33	129
2	-10	10	49	18	57	26	0	34	61
3	3	11	56	19	363	27	21	35	64
4	3	12	134	20	-4	28	20	36	65
5	1	13	-1149	21	15	29	43	37	462
6	34	14	129	22	13	30	70	38	545
7	73	15	175	23	0	31	305		
8	35	16	99	24	1	32	143		

Surface Heights mm

0 -400 400 390 370 380 410 -410 0

TEST 20				SET 11		microvolts			
1	0	9	10	17	104	25	-3951	33	22
2	-10	10	11	18	54	26	-11	34	32
3	3	11	5	19	213	27	3	35	59
4	1	12	-10	20	-4	28	-2	36	68
5	1	13	-1383	21	15	29	-12	37	305
6	34	14	14	22	14	30	-16	38	137
7	74	15	35	23	0	31	62		
8	28	16	81	24	1	32	14		

Surface Heights mm

0 0 -200 200 200 200 -200 0 0

C1-5

TEST 21			SET 1			microvolts		
1	0	9	21	17	3	25	-4017	33
2	15	10	52	18	25	26	13	34
3	31	11	25	19	31	27	30	35
4	21	12	6	20	16	28	16	36
5	36	13	-1423	21	33	29	16	37
6	64	14	18	22	29	30	-3	38
7	37	15	22	23	21	31	39	82
8	-38	16	23	24	19	32	29	

TEST 21			SET 2			microvolts		
1	0	9	22	17	61	25	-4014	33
2	17	10	53	18	100	26	13	34
3	30	11	26	19	142	27	29	35
4	19	12	5	20	15	28	15	36
5	33	13	-1415	21	32	29	17	37
6	63	14	19	22	29	30	-8	38
7	34	15	57	23	20	31	45	
8	-37	16	72	24	17	32	34	

Surface Heights mm							
0.	0	-190	190	230	190	-190	0 0

TEST 21			SET 3			microvolts		
1	0	9	67	17	145	25	-4017	33
2	17	10	123	18	166	26	27	34
3	31	11	114	19	453	27	76	35
4	20	12	117	20	16	28	69	36
5	33	13	-1193	21	33	29	98	37
6	62	14	119	22	29	30	77	38
7	23	15	199	23	21	31	266	
8	-27	16	146	24	17	32	155	

Surface Heights mm							
0	-380	395	455	515	455	400	-385 0

C1-6

			TEST 21	SET 4	microvolts			
1	0	9	176	17	200	25	-3810	33 164
2	16	10	220	18	223	26	112	34 137
3	69	11	198	19	638	27	159	35 166
4	115	12	197	20	22	28	125	36 208
5	122	13	-847	21	73	29	167	37 858
6	197	14	172	22	113	30	131	38 1509
7	257	15	277	23	123	31	594	
8	92	16	194	24	160	32	221	

Surface Heights mm

-575 590 650 715 780 725 660 600 -575

			TEST 21	SET 5	microvolts			
1	0	9	208	17	162	25	-3783	33 238
2	16	10	266	18	102	26	134	34 167
3	74	11	242	19	561	27	188	35 144
4	129	12	253	20	27	28	149	36 101
5	139	13	-756	21	80	29	213	37 789
6	227	14	308	22	125	30	183	38 1617
7	278	15	355	23	136	31	689	
8	108	16	219	24	181	32	313	

Surface Heights mm

-575 590 650 710 775 720 660 600 -575

			TEST 21	SET 5	microvolts			
1	0	9	234	17	108	25	-3773	33 190
2	24	10	293	18	81	26	146	34 96
3	78	11	260	19	486	27	210	35 97
4	142	12	265	20	26	28	173	36 95
5	151	13	-705	21	80	29	235	37 676
6	246	14	273	22	130	30	189	38 1647
7	289	15	309	23	145	31	747	
8	123	16	133	24	196	32	305	

Surface Heights mm

-575 590 645 705 770 715 655 600 -575

		TEST 21		SET 4		microvolts			
1	0	9	176	17	200	25	-3810	33	164
2	16	10	220	18	223	26	112	34	137
3	69	11	198	19	638	27	159	35	166
4	115	12	197	20	22	28	125	36	208
5	122	13	-847	21	73	29	167	37	858
6	197	14	172	22	113	30	131	38	1609
7	257	15	277	23	123	31	594		
8	92	16	194	24	160	32	221		

Surface Heights mm

-575 590 650 715 780 725 660 600 -575

		TEST 21		SET 5		microvolts			
1	0	9	208	17	162	25	-3783	33	238
2	16	10	266	18	102	26	134	34	167
3	74	11	242	19	561	27	188	35	144
4	129	12	253	20	27	28	149	36	101
5	139	13	-756	21	80	29	213	37	789
6	227	14	308	22	125	30	183	38	1617
7	278	15	355	23	136	31	689		
8	108	16	219	24	181	32	313		

Surface Heights mm

-575 590 650 710 775 720 660 600 -575

		TEST 21		SET 6		microvolts			
1	0	9	234	17	108	25	-3773	33	190
2	24	10	293	18	81	26	146	34	96
3	78	11	260	19	486	27	210	35	97
4	142	12	265	20	26	28	173	36	95
5	151	13	-705	21	80	29	235	37	676
6	246	14	273	22	130	30	189	38	1647
7	289	15	309	23	145	31	747		
8	123	16	133	24	196	32	305		

Surface Heights mm

-575 590 645 705 770 715 655 600 -575

C1-7

TEST 21			SET 7			microvolts		
1	0	9	239	17	92	25	-3773	33 177
2	25	10	289	16	81	26	156	34 87
3	80	11	255	19	438	27	223	35 100
4	149	12	251	20	26	28	178	36 95
5	157	13	-690	21	82	29	251	37 596
6	257	14	150	22	136	30	198	38 1631
7	289	15	253	23	154	31	770	
8	137	16	143	24	204	32	160	

Surface Heights mm

-575 590 645 700 760 710 650 600 -575

TEST 21			SET 8			microvolts		
1	0	9	227	17	88	25	-3770	33 121
2	22	10	304	18	77	26	154	34 77
3	54	11	264	19	410	27	220	35 99
4	134	12	245	20	24	28	161	36 97
5	145	13	-753	21	63	29	218	37 568
6	236	14	191	22	112	30	105	38 1570
7	296	15	200	23	149	31	710	
8	108	16	112	24	205	32	195	

Surface Heights mm

-575 590 640 660 700 655 640 600 -575

TEST 21			SET 9			microvolts		
1	0	9	220	17	87	25	-3831	33 127
2	23	10	275	18	82	26	117	34 81
3	50	11	222	19	397	27	198	35 92
4	75	12	213	20	23	28	162	36 96
5	75	13	-772	21	57	29	225	37 538
6	182	14	177	22	73	30	111	38 1389
7	239	15	197	23	81	31	676	
8	111	16	123	24	140	32	196	

Surface Heights mm

-575 590 610 600 600 590 610 600 -575

C1-7

TEST 21			SET 7			microvolts		
1	0	9	239	17	92	25	-3773	33 177
2	25	10	289	16	81	26	156	34 87
3	80	11	255	19	438	27	223	35 100
4	149	12	251	20	26	28	178	36 95
5	157	13	-690	21	82	29	251	37 596
6	257	14	150	22	136	30	198	38 1631
7	289	15	253	23	154	31	770	
8	137	16	143	24	204	32	160	

Surface Heights mm

-575 590 645 700 760 710 650 600 -575

TEST 21			SET 8			microvolts		
1	0	9	227	17	88	25	-3770	33 121
2	22	10	304	18	77	26	154	34 77
3	54	11	264	19	410	27	220	35 99
4	134	12	245	20	24	28	161	36 97
5	145	13	-753	21	63	29	218	37 568
6	236	14	191	22	112	30	105	38 1570
7	296	15	200	23	149	31	710	
8	108	16	112	24	205	32	195	

Surface Heights mm

-575 590 640 660 700 655 640 600 -575

TEST 21			SET 9			microvolts		
1	0	9	220	17	87	25	-3831	33 127
2	23	10	275	18	82	26	117	34 81
3	50	11	222	19	397	27	198	35 92
4	75	12	213	20	23	28	162	36 96
5	75	13	-772	21	57	29	225	37 538
6	192	14	177	22	73	30	111	38 1389
7	239	15	197	23	81	31	676	
8	111	16	123	24	140	32	196	

Surface Heights mm

-575 590 610 600 600 590 610 600 -575

C1-8

TEST 21				SET 10		microvolts			
1	0	9	197	17	85	25	-3911	33	139
2	10	10	251	18	78	26	52	34	74
3	36	11	215	19	388	27	190	35	103
4	58	12	175	20	16	28	152	36	97
5	56	13	-862	21	48	29	177	37	520
6	138	14	170	22	65	30	152	38	1194
7	139	15	201	23	52	31	601		
8	8	16	124	24	76	32	162		

Surface Heights mm

-560 560 560 540 500 540 560 580 -560

TEST 21				SET 11		microvolts			
1	0	9	39	17	77	25	-4009	33	116
2	10	10	83	18	76	26	21	34	71
3	30	11	71	19	364	27	52	35	99
4	22	12	98	20	16	28	41	36	91
5	33	13	-1227	21	34	29	57	37	471
6	68	14	179	22	30	30	61	38	636
7	31	15	161	23	24	31	250		
8	-49	16	118	24	22	32	178		

Surface Heights mm

0 -380 380 380 360 380 400 -400 0

TEST 21				SET 12		microvolts			
1	0	9	24	17	67	25	-4011	33	9
2	9	10	54	18	78	26	12	34	51
3	29	11	30	19	200	27	37	35	87
4	20	12	10	20	15	28	22	36	96
5	33	13	-1431	21	33	29	18	37	309
6	67	14	21	22	29	30	-2	38	271
7	32	15	56	23	23	31	46		
8	-50	16	103	24	20	32	38		

Surface Heights mm

0 0 -200 200 200 200 -200 0 0

C1-9

TEST 22				SET 1		microvolts			
1	0	9	21	17	-8	25	-4033	33	-3
2	19	10	58	18	34	26	17	34	-11
3	36	11	33	19	36	27	44	35	25
4	27	12	11	20	22	28	27	36	61
5	41	13	-1426	21	35	29	22	37	130
6	73	14	18	22	36	30	-5	38	125
7	48	15	33	23	29	31	34		
8	-52	16	30	24	25	32	30		

TEST 22				SET 2		microvolts			
1	0	9	19	17	68	25	-4034	33	33
2	19	10	58	18	113	26	17	34	43
3	37	11	34	19	158	27	44	35	89
4	28	12	11	20	21	28	28	36	114
5	41	13	-1421	21	34	2	21	37	275
6	73	14	25	22	38	30	-4	38	314
7	44	15	88	23	30	31	39		
8	-52	16	93	24	25	32	44		

Surface Heights mm

0 -190 195 250 210 -210 0 0

TEST 22				SET 3		microvolts			
1	0	9	69	17	151	25	-4031	33	124
2	19	10	133	18	165	26	44	34	115
3	36	11	124	19	464	27	88	35	152
4	27	12	132	20	21	28	76	36	156
5	41	13	-1198	21	35	29	104	37	630
6	73	14	212	22	38	30	83	38	865
7	42	15	209	23	29	31	267		
8	-33	16	161	24	24	32	210		

Surface Heights mm

0 -390 400 475 525 480 410 -395 0

C1-10

TEST 22			SET 4			microvolts		
1	0	9	159	17	196	25	-3826	33 181
2	24	10	223	18	207	26	232	34 169
3	76	11	212	19	642	27	179	35 194
4	129	12	211	20	33	28	127	36 192
5	142	13	-851	21	77	29	170	37 854
6	212	14	306	22	125	30	137	38 1704
7	269	15	282	23	133	31	605	
8	138	16	204	24	167	32	305	

Surface Heights mm

-570 590 660 720 780 725 665 605 -580

TEST 22			SET 5			microvolts		
1	0	9	209	17	99	25	-3794	33 182
2	28	10	275	18	87	26	295	34 109
3	81	11	257	19	521	27	213	35 112
4	145	12	262	20	34	28	159	36 99
5	161	13	-722	21	84	29	222	37 723
6	246	14	305	22	135	30	171	38 1698
7	304	15	267	23	149	31	737	
8	161	16	153	24	199	32	295	

Surface Heights mm

-570 590 660 720 775 720 665 605 -580

TEST 22			SET 6			microvolts		
1	0	9	222	17	83	25	-3793	33 169
2	28	10	288	18	84	26	290	34 94
3	81	11	268	19	483	27	214	35 96
4	151	12	255	20	34	28	162	36 100
5	167	13	-709	21	85	29	232	37 673
6	253	14	277	22	139	30	174	38 1694
7	305	15	252	23	156	31	758	
8	153	16	125	24	208	32	279	

Surface Heights mm

-570 590 655 710 770 715 660 605 -580

C1-11

TEST 22			SET 7			microvolts		
1	0	9	232	17	81	25	-3793	33 125
2	31	10	305	18	82	26	282	34 78
3	87	11	264	19	431	27	231	35 96
4	159	12	242	20	31	28	172	36 101
5	173	13	-696	21	86	29	236	37 596
6	261	14	147	22	142	30	167	38 1677
7	303	15	228	23	161	31	777	
8	143	16	114	24	219	32	230	

Surface Heights mm

-570 590 650 705 760 710 655 605 -580

TEST 22			SET 8			microvolts		
1	0	9	209	17	82	25	-3791	33 134
2	27	10	292	18	85	26	233	34 81
3	83	11	285	19	413	27	216	35 100
4	162	12	221	20	29	28	138	36 101
5	178	13	-730	21	75	29	171	37 577
6	263	14	189	22	142	30	162	38 1630
7	304	15	200	23	167	31	757	
8	128	16	117	24	232	32	202	

Surface Heights mm

-570 590 650 685 730 680 650 605 -580

TEST 22			SET 9			microvolts		
1	0	9	200	17	81	25	-3847	33 134
2	29	10	273	18	85	26	167	34 80
3	60	11	237	19	386	27	190	35 105
4	85	12	204	20	28	28	178	36 103
5	90	13	-761	21	58	29	190	37 539
6	187	14	136	22	81	30	124	38 1395
7	244	15	229	23	87	31	691	
8	112	16	129	24	147	32	180	

Surface Heights mm

-570 590 610 580 600 580 610 605 -580

C1-12

			TEST 22	SET 10	microvolts				
1	0	9	249	17	81	25	-3918	33	166
2	21	10	245	18	82	26	52	34	77
3	48	11	235	19	393	27	191	35	104
4	70	12	235	20	21	28	155	36	101
5	70	13	-841	21	52	29	200	37	517
6	143	14	164	22	74	30	148	38	1216
7	161	15	200	23	60	31	615		
8	-17	16	129	24	88	32	139		

Surface Heights mm

-550 560 560 540 500 540 560 570 -570

		TEST 22		SET 11		microvolts			
1	0	9	65	17	76	25	-4013	33	126
2	19	10	118	18	82	26	32	34	80
3	37	11	140	19	371	27	67	35	98
4	29	12	169	20	21	28	52	36	100
5	42	13	-1096	21	37	29	80	37	491
6	83	14	152	22	5	30	164	38	779
7	62	15	217	23	30	31	350		
8	-33	16	128	24	34	32	162		

Surface Heights mm

0 -440 440 420 390 410 440 -440 0

CI-13

TEST 23				SET 1				microvolts		
1	0	9	27	17	-9	25	-4035	33	1	
2	20	10	61	18	36	26	18	34	-8	
3	41	11	36	19	34	27	47	35	28	
4	30	12	14	20	24	28	30	36	63	
5	44	13	-1430	21	37	29	26	37	131	
6	75	14	22	22	39	30	-2	38	29	
7	41	15	36	23	31	31	43			
8	-70	16	32	24	27	32	30			

TEST 23				SET 2				microvolts		
1	0	9	27	17	60	25	-4038	33	33	
2	20	10	59	18	108	26	19	34	37	
3	39	11	35	19	161	27	47	35	91	
4	29	12	13	20	22	28	30	36	114	
5	44	13	-1424	21	37	29	26	37	295	
6	77	14	35	22	39	30	-3	38	235	
7	38	15	87	23	32	31	45			
8	-69	16	91	24	27	32	48			

Surface Heights mm

0 0 -190 200 230 200 -190 0 0

TEST 23				SET 3				microvolts		
1	0	9	82	17	122	25	-4032	33	114	
2	20	10	137	18	161	26	32	34	90	
3	40	11	117	19	467	27	85	35	137	
4	29	12	123	20	24	28	74	36	154	
5	44	13	-1182	21	36	29	99	37	651	
6	75	14	170	22	38	30	78	38	804	
7	36	15	201	23	32	31	267			
8	-53	16	143	24	26	32	200			

Surface Heights mm

0 -380 400 460 520 460 410 -380 0

C1-14

TEST 23			SET 4			microvolts			
1	0	9	171	17	168	25	-3815	33	168
2	35	10	215	18	202	26	100	34	129
3	87	11	186	19	651	27	157	35	175
4	126	12	191	20	40	28	122	36	190
5	139	13	-842	21	81	29	161	37	871
6	201	14	231	22	126	30	121	38	1669
7	297	15	292	23	129	31	601		
8	43	16	194	24	165	32	266		

Surface Heights mm

-575 595 650 715 780 720 655 600 -575

TEST 23			SET 5			microvolts			
1	0	9	215	17	77	25	-3767	33	154
2	37	10	279	18	86	26	128	34	78
3	93	11	253	19	496	27	189	35	99
4	150	12	241	20	41	28	148	36	101
5	157	13	-672	21	87	29	200	37	668
6	241	14	294	22	140	30	169	38	1657
7	357	15	210	23	152	31	771		
8	84	16	130	24	201	32	295		

Surface Heights mm

-575 595 650 710 765 720 650 600 -575

TEST 23			SET 6			microvolts			
1	0	9	235	17	69	25	-3767	33	129
2	37	10	309	18	91	26	136	34	90
3	94	11	278	19	446	27	204	35	100
4	154	12	251	20	42	28	168	36	102
5	160	13	-656	21	90	29	231	37	606
6	247	14	172	22	142	30	182	38	1645
7	355	15	217	23	157	31	776		
8	96	16	147	24	211	32	175		

Surface Heights mm

-575 595 640 700 760 710 645 600 -575

C1-15

TEST 23			SET 7			microvolts		
1	0	9	234	17	75	25	-3767	33 138
2	39	10	314	18	87	26	138	34 92
3	94	11	285	19	428	27	212	35 104
4	155	12	248	20	40	28	189	36 100
5	161	13	-554	21	90	29	239	37 587
6	250	14	113	22	145	30	168	38 1633
7	353	15	222	23	159	31	783	
8	99	16	143	24	212	32	127	

Surface Heights mm

-575 595 640 695 750 700 645 600 -575

TEST 23			SET 8			microvolts		
1	0	9	204	17	78	25	-3766	33 143
2	34	10	293	18	86	26	145	34 82
3	73	11	267	19	416	27	212	35 107
4	151	12	206	20	33	28	169	36 101
5	158	13	-703	21	71	29	225	37 573
6	243	14	129	22	136	30	130	38 1551
7	357	15	235	23	160	31	741	
8	85	16	137	24	216	32	195	

Surface Heights mm

-575 595 640 650 700 670 640 600 -575

TEST 23			SET 9			microvolts		
1	0	9	244	17	79	25	-3833	33 129
2	34	10	292	18	91	26	131	34 89
3	68	11	253	19	416	27	208	35 101
4	90	12	209	20	34	28	171	36 103
5	99	13	-744	21	67	29	223	37 544
6	187	14	176	22	87	30	139	38 1372
7	281	15	201	23	92	31	726	
8	84	16	132	24	147	32	137	

Surface Heights mm

-575 595 610 600 600 600 620 600 -575

C1-16

TEST 23			SET 10			microvolts		
1	0	9	227	17	70	25	-3903	33 118
2	22	10	259	18	88	26	94	34 92
3	57	11	260	19	397	27	200	35 103
4	74	12	229	20	32	28	150	36 101
5	71	13	-810	21	57	29	183	37 542
6	164	14	188	22	72	30	143	38 1173
7	182	15	199	23	70	31	633	
8	-23	16	122	24	97	32	221	

Surface Heights mm

-550 560 570 540 500 550 580 590 -570

TEST 23			SET 11			microvolts		
1	0	9	69	17	77	25	-4020	33 150
2	20	10	117	18	87	26	34	34 76
3	41	11	159	19	372	27	72	35 100
4	33	12	215	20	25	28	58	36 102
5	44	13	-1079	21	39	29	136	37 498
6	86	14	171	22	39	30	111	38 681
7	59	15	193	23	33	31	396	
8	-48	16	135	24	40	32	156	

Surface Heights mm

0 -430 440 420 400 420 450 -440 0

	TEST 24			SET 1			microvolts		
1	0	9	25	17	-7	25	-4024	33	0
2	18	10	59	18	36	26	18	34	-9
3	38	11	34	19	34	27	47	35	27
4	27	12	13	20	22	28	29	36	63
5	41	13	-1425	21	37	29	25	37	128
6	75	14	20	22	39	30	-3	38	70
7	43	15	36	23	30	31	41		
8	-52	16	33	24	25	32	28		

	TEST 24			SET 2			microvolts		
1	0	9	24	17	59	25	-4024	33	29
2	19	10	60	18	100	26	17	34	40
3	40	11	35	19	143	27	46	35	94
4	29	12	14	20	21	28	28	36	126
5	42	13	-1420	21	35	29	25	37	290
6	75	14	27	22	38	30	-3	38	262
7	40	15	88	23	30	31	44		
8	-53	16	95	24	27	32	40		

Surface Heights mm

0 0 -200 200 230 200 -200 0 0

	TEST 24			SET 3			microvolts		
1	0	9	82	17	136	25	-4028	33	129
2	20	10	141	18	149	26	33	34	118
3	39	11	124	19	450	27	92	35	154
4	29	12	131	20	22	28	78	36	177
5	42	13	-1190	21	35	29	109	37	659
6	74	14	221	22	39	30	82	38	822
7	36	15	205	23	31	31	266		
8	-35	16	161	24	27	32	242		

Surface Heights mm

0 -400 410 480 520 470 410 -400 0

C1-18

	TEST 24			SET 4			microvolts		
1	0	9	182	17	191	25	-3805	33	-190
2	40	10	236	18	192	26	123	34	164
3	94	11	214	19	641	27	181	35	199
4	142	12	212	20	43	28	133	36	222
5	153	13	-842	21	84	29	182	37	898
6	224	14	331	22	123	30	136	38	1715
7	290	15	286	23	136	31	610		
8	81	16	209	24	164	32	350		

Surface Heights mm

-580 610 675 740 785 730 670 610 -580

	TEST 24			SET 5			microvolts		
1	0	9	220	17	100	25	-3776	33	203
2	42	10	283	18	90	26	144	34	136
3	98	11	253	19	561	27	215	35	128
4	156	12	257	20	43	28	157	36	108
5	172	13	-740	21	91	29	225	37	801
6	250	14	338	22	123	30	183	38	1711
7	323	15	274	23	153	31	715		
8	108	16	156	24	189	32	386		

Surface Heights mm

-580 610 675 740 780 730 670 610 -580

	TEST 24			SET 6			microvolts		
1	0	9	230	17	88	25	-3767	33	176
2	43	10	293	18	90	26	151	34	105
3	100	11	263	19	505	27	227	35	106
4	164	12	269	20	44	28	166	36	102
5	178	13	-696	21	92	29	235	37	717
6	261	14	309	22	136	30	181	38	1705
7	334	15	243	23	160	31	760		
8	120	16	123	24	201	32	343		

Surface Heights mm

-580 610 670 735 775 720 665 610 -580

C1-19

			TEST 24	SET 7	microvolts				
1	0	9	240	17	79	25	-3765	33	169
2	41	10	302	18	87	26	162	34	82
3	101	11	276	19	445	27	238	35	101
4	173	12	288	20	43	28	175	36	103
5	188	13	-677	21	96	29	245	37	642
6	276	14	159	22	142	30	181	38	1693
7	338	15	230	23	170	31	782		
8	133	16	132	24	212	32	251		

Surface Heights mm

-580 610 665 730 770 715 660 610 -590

			TEST 24	SET 8	microvolts				
1	0	9	259	17	80	25	-3757	33	112
2	41	10	313	18	87	26	163	34	95
3	104	11	259	19	418	27	229	35	96
4	181	12	234	20	38	28	161	36	102
5	188	13	-712	21	96	29	227	37	587
6	287	14	202	22	145	30	161	38	1657
7	336	15	218	23	173	31	795		
8	140	16	127	24	220	32	156		

Surface Heights mm

-580 610 660 710 750 700 660 610 -580

			TEST 24	SET	microvolts				
1	0	9	242	17	81	25	-3770	33	151
2	36	10	287	18	87	26	172	34	84
3	72	11	245	19	414	27	250	35	90
4	157	12	155	20	37	28	179	36	104
5	168	13	-753	21	72	29	215	37	572
6	256	14	165	22	119	30	81	38	1566
7	339	15	223	23	150	31	727		
8	98	16	127	24	197	32	172		

Surface Heights mm

-580 610 640 660 700 660 640 610 -580

C1-20

	TEST 24			SET 10			microvolts		
1	0	9	231	17	75	25	-3840	33	142
2	35	10	283	18	87	26	137	34	69
3	67	11	220	19	61	27	218	35	101
4	94	12	219	20	35	28	191	36	102
5	94	13	-756	21	65	29	198	37	55
6	216	14	162	22	81	30	120	38	1384
7	272	15	207	23	87	31	700		
8	89	16	125	24	137	32	190		

Surface Heights mm

-580 600 610 600 600 600 610 610 -580

	TEST 24			SET 11			microvolts		
1	0	9	183	17	78	25	-3912	33	147
2	20	10	250	18	88	26	52	34	80
3	54	11	253	19	397	27	192	35	95
4	68	12	180	20	24	28	161	36	101
5	68	13	-844	21	56	29	224	37	540
6	150	14	176	22	73	30	126	38	1173
7	169	15	221	23	64	31	608		
8	-3	16	125	24	97	32	191		

Surface Heights mm

-560 580 570 540 500 540 570 580 -570

	TEST 24			SET 12			microvolts		
1	0	9	54	17	68	25	-4004	33	104
2	18	10	92	18	86	26	25	34	81
3	38	11	80	19	372	27	64	35	98
4	30	12	109	20	23	28	52	36	102
5	44	13	-1217	21	38	29	57	37	492
6	77	14	153	22	37	30	42	38	618
7	48	15	202	23	31	31	52		
8	-50	16	121	24	27	32	187		

Surface Heights mm

0 -390 400 370 360 370 400 -390 0

C1-21

TEST 26			SET 1			microvolts			
1	0	9	-25	17	93	25	-3971	33	-27
2	-20	10	10	18	-2	26	-12	34	-30
3	6	11	-5	19	17	27	55	35	0
4	-10	12	-10	20	-3	28	6	36	72
5	-30	13	-1473	21	27	29	-1	37	108
6	30	14	-10	22	13	30	-37	38	124
7	55	15	-7	23	-10	31	-1		
8	236	16	8	24	-12	32	-2		

TEST			26	SET		2	microvolts		
1	2	3	4	5	6	7	8	9	10
1	0	9	-25	17	157	25	-3971	33	6
2	-20	10	10	18	58	26	-12	34	20
3	6	11	-5	19	114	27	55	35	53
4	-10	12	-11	20	-3	28	7	36	127
5	-30	13	-1463	21	28	29	-3	37	267
6	30	14	-1	22	12	30	-37	38	350
7	55	15	48	23	-9	31	1		
8	236	16	69	24	-12	32	17		

Surface Heights mm

0 0 -200 210 260 210 -200 0 0

TEST 26			SET 3			microvolts			
1	0	9	31	17	228	25	-3957	33	89
2	-21	10	93	18	112	26	5	34	85
3	6	11	84	19	397	27	101	35	106
4	-10	12	107	20	-3	28	56	36	167
5	-30	13	-1195	21	27	29	79	37	622
6	29	14	103	22	14	30	39	38	902
7	54	15	141	23	-10	31	237		
8	255	16	122	24	-13	32	128		

Surface Heights mm

0 -400 415 475 530 475 420 -400 0

TEST 26			SET 4			microvolts		
1	0	9	127	17	280	25	-3716	33 137
2	17	10	185	18	153	26	91	34 129
3	76	11	161	19	597	27	182	35 142
4	114	12	188	20	30	28	108	36 200
5	79	13	-850	21	62	29	145	37 840
6	190	14	173	22	121	30	87	38 1821
7	339	15	212	23	104	31	597	
8	370	16	168	24	134	32	207	

Surface Heights mm

-595 630 695 750 810 750 680 620 -590

TEST 26			SET 5			microvolts		
1	0	9	179	17	192	25	-5050	33 160
2	24	10	255	18	56	26	121	34 106
3	88	11	233	19	475	27	124	35 108
4	138	12	262	20	36	28	142	36 145
5	101	13	-688	21	92	29	195	37 674
6	227	14	194	22	143	30	138	38 1811
7	405	15	221	23	124	31	760	
8	406	16	131	24	169	32	222	

Surface Heights mm

-595 630 695 750 810 750 680 620 -590

TEST 26			SET 6			microvolts		
1	0	9	192	17	178	25	-3662	33 148
2	24	10	270	18	45	26	126	34 96
3	91	11	247	19	439	27	234	35 97
4	143	12	268	20	36	28	154	36 146
5	187	13	-668	21	95	29	214	37 618
6	236	14	201	22	149	30	155	38 1802
7	418	15	214	23	133	31	762	
8	414	16	111	24	181	32	208	

Surface Heights mm

-595 630 680 745 800 745 680 620 -590

		TEST 26		SET 7		microvolts			
1	0	9	191	17	165	25	-3658	33	201
2	25	10	264	18	42	26	124	34	136
3	93	11	239	19	414	27	237	35	104
4	147	12	236	20	35	28	151	36	142
5	112	13	-690	21	96	29	202	37	597
6	244	14	141	22	152	30	153	38	1791
7	423	15	208	23	138	31	773		
8	414	16	104	24	188	32	225		

Surface Heights mm

-595 630 680 735 790 735 675 620 -590

		TEST 26		SET 8		microvolts			
1	0	9	186	17	160	25	-3654	33	204
2	25	10	260	18	37	26	129	34	128
3	95	11	221	19	416	27	241	35	91
4	150	12	191	20	35	28	151	36	138
5	115	13	-708	21	96	29	209	37	597
6	238	14	135	22	156	30	118	38	1781
7	426	15	195	23	140	31	757		
8	408	16	91	24	191	32	212		

Surface Heights mm

-595 630 680 735 785 730 675 620 -590

		TEST 26		SET 9		microvolts			
1	0	9	193	17	158	25	-3657	33	100
2	25	10	270	18	38	26	129	34	40
3	95	11	235	19	400	27	248	35	52
4	151	12	191	20	34	28	153	36	104
5	118	13	-700	21	97	29	208	37	578
6	244	14	120	22	157	30	103	38	1771
7	427	15	135	23	143	31	755		
8	409	16	71	24	197	32	156		

Surface Heights mm

-595 630 680 730 780 725 675 620 -590

C1-24

TEST 26			SET 10			microvolts			
1	0	9	192	17	155	25	-3653	33	72
2	24	10	249	18	35	26	131	34	27
3	96	11	201	19	394	27	243	35	50
4	154	12	159	20	33	28	145	36	107
5	118	13	-710	21	96	29	179	37	575
6	247	14	113	22	157	30	75	38	1760
7	427	15	113	23	141	31	751		
8	413	16	66	24	192	32	142		

Surface Heights mm

-595 630 680 725 775 725 675 620 -590

TEST 26			SET 11			microvolts			
1	0	9	186	17	146	25	-3650	33	59
2	22	10	232	18	36	26	122	34	25
3	94	11	186	19	394	27	238	35	51
4	154	12	149	20	30	28	146	36	106
5	118	13	-718	21	96	29	157	37	574
6	242	14	92	22	157	30	62	38	1752
7	432	15	102	23	141	31	744		
8	402	16	72	24	196	32	107		

Surface Heights mm

-595 630 675 720 770 720 675 620 -590

TEST 26			SET 12			microvolts			
1	0	9	179	17	153	25	-3653	33	55
2	20	10	239	18	36	26	119	34	30
3	94	11	181	19	385	27	223	35	47
4	154	12	142	20	30	28	129	36	106
5	116	13	-717	21	97	29	162	37	562
6	243	14	81	22	158	30	80	38	1741
7	430	15	92	23	145	31	741		
8	409	16	66	24	204	32	95		

Surface Heights mm

-595 630 675 715 765 710 670 620 -590

C1-25

TEST 26				SET 13		microvolts			
1	0	9	164	17	162	25	-3650	33	76
2	10	10	219	18	37	26	110	34	39
3	91	11	182	19	385	27	210	35	52
4	148	12	173	20	24	28	119	36	102
5	111	13	-717	21	95	29	144	37	571
6	234	14	114	22	158	30	113	38	1720
7	435	15	111	23	140	31	735		
8	399	16	78	24	188	32	123		

Surface Heights mm

-595 630 675 700 755 700 670 620 -590

TEST 26				SET 14		microvolts			
1	0	9	195	17	173	25	-3657	33	97
2	9	10	235	18	39	26	114	34	54
3	52	11	186	19	372	27	213	35	55
4	108	12	177	20	20	28	139	36	106
5	91	13	-747	21	64	29	190	37	558
6	227	14	114	22	125	30	72	38	1638
7	423	15	144	23	117	31	696		
8	421	16	86	24	180	32	122		

Surface Heights mm

-595 630 660 650 705 650 655 620 -590

APPENDIX C2

STRESSES - BIN 1

C2-1

TEST 20 SET 2

Weight= 237.1 N Volume= 15.4 Litres
 Density= 1565.7 Kg/M³ Weight Factor= 1.324

Normal Stress(Pa)		Shear Stress/Friction Angle	
-34.7	26.0	7.4 Pa	9.6 Pa
-31.5	0.0	0.00 Deg	0.00 Deg
23.0	0.0		
0.0	-32.9		
27.4	-26.0		
-35.1	83.4	29.6 Pa	16.8 Pa
-64.1	0.0	0.00 Deg	0.00 Deg
-23.8	51.6		
0.0	32.7		
0.0	0.0		
519.6	388.1	512.0 Pa	561.8 Pa
1496.0	1450.6	17.19 Deg	18.89 Deg
2221.9	1873.7		
2208.4	2520.3		
2059.4	2186.0		

TEST 20 SET 3

Weight= 831.7 N Volume= 53.6 Litres
 Density= 1580.5 Kg/M³ Weight Factor= 1.175

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	23.1	-3.3 Pa	45.3 Pa
-28.0	0.0	0.00 Deg	0.00 Deg
20.4	27.4		
-33.7	0.0		
0.0	-23.1		
497.9	628.9	725.9 Pa	731.5 Pa
1421.3	1673.0	21.87 Deg	19.91 Deg
1928.5	2382.6		
2400.1	2408.2		
2870.8	3125.4		
3515.4	3046.1	1295.4 Pa	1422.1 Pa
3746.9	4141.1	19.45 Deg	21.15 Deg
4062.6	3796.2		
3946.4	4245.8		
3245.7	3417.5		

C2-2

TEST 20 SET 4

Weight= 1785.8 N Volume= 119.2 Litres
 Density= 1608.1 Kg/M³ Weight Factor= 1.263

Normal Stress(Pa)		Shear Stress/Friction Angle	
628.2	421.1	856.6 Pa	730.5 Pa
1323.2	1349.3	20.14 Deg	18.03 Deg
2254.9	2676.9		
3619.6	3356.9		
3895.8	3566.9		
4580.1	3934.6	1866.7 Pa	1873.3 Pa
4519.9	5200.8	21.23 Deg	20.68 Deg
4739.6	5267.1		
5016.9	4893.9		
5131.5	5673.4		
5974.6	5634.4	1949.7 Pa	2161.8 Pa
5589.7	6452.7	19.22 Deg	20.74 Deg
6033.4	5596.7		
5760.2	6197.9		
4747.0	4928.6		

TEST 20 SET 5

Weight= 1767.0 N Volume= 111.8 Litres
 Density= 1611.1 Kg/M³ Weight Factor= 1.277

Normal Stress(Pa)		Shear Stress/Friction Angle	
434.7	378.7	1040.4 Pa	865.0 Pa
1703.0	1627.8	19.34 Deg	17.12 Deg
2944.3	3272.2		
4685.2	4251.3		
5155.9	4684.1		
6085.3	5465.9	2325.0 Pa	2381.2 Pa
6269.3	7076.8	20.04 Deg	19.81 Deg
6543.6	7068.5		
6320.4	6619.6		
6641.2	7103.2		
5415.7	4518.0	1431.0 Pa	1570.9 Pa
4466.2	6422.2	22.81 Deg	24.83 Deg
3310.3	2528.8		
2306.3	2323.9		
1481.6	1438.3		

C2-3

TEST 20 SET 6

Weight= 1678.8 N Volume= 111.8 Litres
 Density= 1530.7 Kg/M³ Weight Factor= 1.234

Normal Stress(Pa)		Shear Stress/Friction Angle	
258.6	339.1	1009.4 Pa	833.4 Pa
1617.3	1656.2	18.76 Deg	16.51 Deg
2996.8	3279.0		
4778.0	4264.1		
5317.7	4698.8		
6341.7	5207.4	2239.0 Pa	2252.4 Pa
6390.5	7141.9	19.97 Deg	19.67 Deg
6382.7	7508.6		
6111.4	6766.4		
5667.6	5547.5		
5448.5	4785.9	1250.6 Pa	1376.4 Pa
4206.0	4516.2	20.26 Deg	23.98 Deg
3012.5	2590.7		
2687.5	2145.0		
1518.6	1423.1		

TEST 20 SET 7

Weight= 1644.6 N Volume= 104.2 Litres
 Density= 1608.9 Kg/M³ Weight Factor= 1.282

Normal Stress(Pa)		Shear Stress/Friction Angle	
235.0	301.8	1055.1 Pa	840.5 Pa
763.3	991.0	22.69 Deg	20.64 Deg
2578.1	2478.7		
4336.1	3631.0		
4724.9	3847.5		
6041.3	5406.7	2165.5 Pa	2283.1 Pa
6914.0	6794.0	19.44 Deg	20.29 Deg
6396.5	6296.7		
6203.0	5569.6		
5371.6	6896.0		
5028.4	5084.6	1268.0 Pa	1351.7 Pa
4203.5	3654.7	20.73 Deg	23.52 Deg
3127.8	2961.8		
2760.7	2191.7		
1636.2	1511.1		

TEST 20 SET 8

Weight= 1438.3 N Volume= 90.8 Litres
 Density= 1614.7 Kg/M³ Weight Factor= 1.234

Normal Stress(Pa)		Shear Stress/Friction Angle	
129.3	217.9	813.5 Pa	633.8 Pa
676.1	701.6	28.36 Deg	25.04 Deg
1305.4	1179.0		
1556.8	1840.1		
3629.3	2760.3		
4869.2	4390.1	1965.8 Pa	2029.1 Pa
5940.8	6392.2	20.52 Deg	20.40 Deg
5548.6	6351.6		
4411.0	5119.0		
5510.0	5432.7		
4660.1	4228.2	1182.0 Pa	1255.1 Pa
4249.8	4282.5	20.05 Deg	22.73 Deg
3043.0	2764.6		
2772.5	2382.6		
1546.8	1422.7		

TEST 20 SET 9

Weight= 1214.4 N Volume= 76.4 Litres
 Density= 1620.3 Kg/M³ Weight Factor= 1.245

Normal Stress(Pa)		Shear Stress/Friction Angle	
-326.0	24.4	470.9 Pa	402.2 Pa
207.5	481.2	33.54 Deg	23.34 Deg
884.9	1015.1		
892.2	1051.7		
1856.1	2027.0		
1615.1	1841.7	1723.4 Pa	1774.6 Pa
4817.7	4712.9	22.10 Deg	23.27 Deg
5400.5	6163.7		
5913.6	5193.9		
4272.9	3653.0		
4608.7	3815.7	1169.3 Pa	1222.3 Pa
3900.8	4219.0	20.59 Deg	23.20 Deg
3259.1	2817.7		
2392.8	2231.5		
1444.5	1337.1		

TEST 20 SET 10

Weight= 644.2 N Volume= 40.6 Litres
 Density= 1615.7 Kg/M³ Weight Factor= 1.161

Normal Stress(Pa)		Shear Stress/Friction Angle	
-384.6	22.8	45.2 Pa	78.4 Pa
-119.7	52.8	0.00 Deg	0.00 Deg
0.0	-27.1		
-99.9	0		
48.1	0		
276.8	438.7	691.4 Pa	799.6 Pa
702.4	738.0	25.69 Deg	29.81 Deg
913.8	1086.8		
1289.2	1548.5		
3668.9	2982.4		
3445.8	3324.6	1005.1 Pa	1014.6 Pa
3745.5	3967.7	20.88 Deg	21.75 Deg
2775.2	2464.8		
2044.3	1986.0		
1320.9	1156.3		

TEST 20 SET 11

Weight= 194.1 N Volume= 12.2 Litres
 Density= 1616.7 Kg/M³ Weight Factor= 1.088

Normal Stress(Pa)		Shear Stress/Friction Angle	
-313.4	21.3	45.4 Pa	76.0 Pa
-103.6	49.5	0.00 Deg	0.00 Deg
-37.7	0.0		
-93.6	0.0		
45.1	0.0		
57.6	34.2	16.2 Pa	77.4 Pa
-52.6	98.8	0.00 Deg	0.00 Deg
-73.4	84.8		
-24.1	-26.9		
137.4	-66.5		
160.0	-49.0	512.1 Pa	521.5 Pa
733.3	585.2	23.95 Deg	28.83 Deg
2101.3	1564.5		
1914.5	1709.9		
1161.3	1168.4		

TEST 21 SET 2

Weight= 207.4 N Volume= 12.6 Litres
 Density= 1672.3 Kg/M³ Weight Factor= 1.516

Normal Stress(Pa)		Shear Stress/Friction Angle	
79.4	-29.7	-12.6 Pa	11.0 Pa
-36.1	-34.5	0.00 Deg	0.00 Deg
-52.6	0.0		
-130.4	-37.7		
-31.4	-59.5		
40.2	0.0	30.1 Pa	23.1 Pa
36.7	45.9	0.00 Deg	0.00 Deg
34.1	-53.1		
33.7	37.4		
-31.9	0.0		
37.2	170.9	42.6 Pa	529.0 Pa
966.9	933.1	16.59 Deg	21.05 Deg
1888.7	1465.9		
2035.8	2132.8		
2604.3	2264.4		

TEST 21 SET 3

Weight= 803.0 N Volume= 51.4 Litres
 Density= 1591.2 Kg/M³ Weight Factor= 1.189

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	0.0	-46.3 Pa	0.0 Pa
0.0	0.0	0.00 Deg	0.00 Deg
-25.6	0.0		
-103.3	0.0		
-49.2	-46.7		
346.3	524.0	678.3 Pa	685.7 Pa
1327.4	1656.5	21.52 Deg	19.33 Deg
1897.5	2456.7		
2348.9	2406.9		
2774.1	2907.5		
2944.2	3376.4	1319.9 Pa	1501.4 Pa
3834.0	3517.8	20.00 Deg	23.92 Deg
3717.1	3027.6		
3909.3	3475.6		
3863.1	3488.6		

CZ-7

TEST 21 SET 4

Weight= 1684.3 N Volume= 112.0 Litres
 Density= 1532.9 Kg/M³ Weight Factor= 1.228

Normal Stress(Pa)		Shear Stress/Friction Angle	
32.2	144.6	751.3 Pa	612.9 Pa
1111.5	1117.0	21.69 Deg	16.39 Deg
2001.6	2403.4		
3027.7	3112.6		
3382.4	3397.1		
4227.2	3827.0		
4604.3	4798.2	1754.7 Pa	1731.7 Pa
4637.7	5218.8	20.79 Deg	20.42 Deg
4716.2	4578.2		
4939.5	5030.3		
4637.0	5314.3		
5705.3	5582.5	1961.0 Pa	2260.0 Pa
5337.8	4459.2	20.12 Deg	24.03 Deg
5602.7	4944.7		
5614.8	4986.9		

TEST 21 SET 5

Weight= 1693.1 N Volume= 111.4 Litres
 Density= 1549.3 Kg/M³ Weight Factor= 1.121

Normal Stress(Pa)		Shear Stress/Friction Angle	
29.4	241.9	751.2 Pa	632.3 Pa
1148.0	1197.9	20.07 Deg	16.63 Deg
2099.0	2507.1		
3309.8	3203.1		
3783.6	3562.5		
4333.2	4269.4		
5070.1	5364.1	1854.7 Pa	1851.2 Pa
3392.0	5612.3	15.65 Deg	18.83 Deg
5399.5	5451.7		
5830.4	6373.1		
7970.0	7174.9		
6800.4	7326.6	1562.9 Pa	1868.7 Pa
5584.4	4863.0	15.55 Deg	21.05 Deg
4127.4	3833.2		
1977.1	1409.6		

C2-8

TEST 21 SET 6

Weight= 1726.2 N Volume= 110.4 Litres
 Density= 1593.9 Kg/M³ Weight Factor= 1.181

Normal Stress(Pa)		Shear Stress/Friction Angle	
278.4	231.7	827.8 Pa	694.9 Pa
1322.4	1262.4	18.51 Deg	16.29 Deg
2478.3	2779.7		
3894.4	3639.7		
4452.1	4101.9		
5035.7	4945.4	2104.2 Pa	2125.1 Pa
6086.0	6440.0	19.34 Deg	18.58 Deg
6399.2	7230.5		
6162.2	6386.8		
6442.8	6932.9		
7385.4	7348.2	1414.1 Pa	1634.3 Pa
6176.5	6195.9	18.31 Deg	21.61 Deg
3302.8	3147.3		
2872.4	2508.4		
1507.8	1299.8		

TEST 21 SET 7

Weight= 1708.5 N Volume= 109.4 Litres
 Density= 1592.0 Kg/M³ Weight Factor= 1.235

Normal Stress(Pa)		Shear Stress/Friction Angle	
323.4	242.3	965.5 Pa	726.5 Pa
1441.2	1375.9	17.57 Deg	15.49 Deg
2740.7	3078.5		
4283.6	4081.1		
4935.5	4482.0		
5722.1	5558.6	2245.7 Pa	2293.8 Pa
6511.6	7218.6	19.70 Deg	18.15 Deg
6578.7	7799.5		
6304.9	7164.5		
6371.2	7587.3		
3996.6	3646.0	1322.4 Pa	1460.5 Pa
5197.1	6045.3	21.55 Deg	24.09 Deg
3766.6	3028.1		
2545.2	2724.5		
1576.3	1358.8		

TEST 21 SET 8

Weight= 1641.3 N Volume= 102.6 Litres
 Density= 1630.7 Kg/M³ Weight Factor= 1.282

Normal Stress(Pa)		Shear Stress/Friction Angle	
235.0	201.2	923.5 Pa	763.5 Pa
702.4	874.6	21.00 Deg	17.24 Deg
2512.0	2479.2		
4006.3	4077.8		
4566.6	4678.4		
4956.3	5690.4	2131.1 Pa	2186.0 Pa
6388.3	7378.0	18.69 Deg	15.90 Deg
7262.4	7247.8		
6802.0	6993.8		
6452.7	4232.6		
5438.2	4796.8	1278.4 Pa	1426.1 Pa
4157.7	4345.2	21.01 Deg	23.76 Deg
2900.4	2841.6		
2523.7	2793.2		
1517.5	1477.9		

TEST 21 SET 9

Weight= 1441.6 N Volume= 91.2 Litres
 Density= 1611.3 Kg/M³ Weight Factor= 1.235

Normal Stress(Pa)		Shear Stress/Friction Angle	
258.8	169.6	693.9 Pa	553.9 Pa
558.9	674.0	27.81 Deg	21.63 Deg
1156.4	1266.1		
1380.9	1841.4		
3018.1	2932.0		
4872.8	4049.4	1994.9 Pa	1999.3 Pa
5945.2	6284.7	19.89 Deg	20.20 Deg
6191.2	7030.4		
5401.2	6373.0		
5384.0	4304.0		
4815.0	4648.8	1189.4 Pa	1280.9 Pa
3937.9	4385.3	20.48 Deg	22.23 Deg
3139.4	2853.9		
2402.7	2452.5		
1605.2	1391.4		

TEST 21 SET 10

Weight= 1226.5 N Volume= 76.8 Litres
 Density= 1628.0 Kg/M³ Weight Factor= 1.235

Normal Stress(Pa)		Shear Stress/Friction Angle	
-161.8	0.0	350.5 Pa	315.8 Pa
147.1	421.4	26.68 Deg	22.80 Deg
792.6	1036.2		
708.4	951.7		
1893.2	1381.6		
1504.8	1516.7	1719.7 Pa	1764.4 Pa
5259.5	5987.1	22.16 Deg	20.15 Deg
5526.4	6550.7		
5210.8	4910.7		
4396.8	5853.6		
4604.3	3703.4	1160.5 Pa	1225.5 Pa
4029.0	4785.3	20.40 Deg	22.07 Deg
3171.7	2650.8		
2346.1	2827.9		
1491.0	1424.1		

TEST 21 SET 11

Weight= 611.1 N Volume= 38.6 Litres
 Density= 1612.1 Kg/M³ Weight Factor= 1.200

Normal Stress(Pa)		Shear Stress/Friction Angle	
-157.2	0.0	-20.0 Pa	23.1 Pa
-28.6	27.3	0.00 Deg	0.00 Deg
20.8	28.0		
-103.3	89.5		
99.4	70.7		
-349.7	302.3	583.6 Pa	643.5 Pa
522.7	800.0	32.37 Deg	28.56 Deg
836.6	1170.2		
1225.9	1215.2		
2325.9	2348.7		
4739.1	4031.7	1051.6 Pa	1042.8 Pa
3040.3	3907.4	20.23 Deg	20.28 Deg
2899.0	2491.0		
2057.4	2615.6		
1393.1	1195.2		

TEST 21 SET 12

Weight= 208.5 N Volume= 12.2 Litres
 Density= 1736.1 Kg/M³ Weight Factor= 1.261

Normal Stress(Pa)		Shear Stress/Friction Angle	
-198.1	-24.7	-17.5 Pa	18.2 Pa
-60.1	0.0	0.00 Deg	0.00 Deg
-21.9	0.0		
-108.4	62.7		
78.3	24.7		
-400.6	-39.7	-25.0 Pa	22.4 Pa
91.5	257.3	0.00 Deg	0.00 Deg
56.7	295.0		
140.0	62.3		
106.2	38.5		
92.7	255.8		
781.1	474.8	560.5 Pa	582.4 Pa
2564.1	2021.7	23.26 Deg	24.99 Deg
1868.9	2329.9		
1521.7	1420.5		

TEST 22 SET 2

Weight= 208.5 N Volume= 14.4 Litres
 Density= 1471.6 Kg/M³ Weight Factor= 1.298

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	-25.5	-14.4 Pa	-3.1 Pa
30.3	-29.5	0.00 Deg	0.00 Deg
22.5	60.5		
0.0	32.3		
0.0	0.0		
0.0	0.0	16.1 Pa	16.5 Pa
-62.8	0.0	0.00 Deg	0.00 Deg
0.0	50.6		
28.8	0		
0.0	7		
222.8	2.6	416.5 Pa	472.4 Pa
1300.8	37.0	14.47 Deg	18.15 Deg
2078.8	1652.8		
2284.8	2291.2		
2380.1	1802.5		

TEST 22 SET 3

Weight= 816.2 N Volume= 54.2 Litres
 Density= 1534.0 Kg/M³ Weight Factor= 1.108

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	-21.7	-18.5 Pa	5.3 Pa
0.0	0.0	0.00 Deg	0.00 Deg
0.0	51.6		
0.0	0.0		
0.0	-21.7		
557.5	941.9	626.8 Pa	656.0 Pa
1286.7	1476.9	19.72 Deg	18.60 Deg
1868.4	2117.2		
2238.7	2243.6		
2823.9	2981.1		
5271.4	4496.0	1247.7 Pa	1391.1 Pa
3553.6	3785.8	17.20 Deg	20.90 Deg
3690.2	3292.4		
4080.7	3881.5		
3369.4	2758.2		

TEST 22 SET 4

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Weight= 1741.6 N Volume= 113.0 Litres
 Density= 1571.1 Kg/M³ Weight Factor= 1.172

Normal Stress(Pa)		Shear Stress/Friction Angle	
153.4	252.8	720.0 Pa	584.6 Pa
1116.3	1118.9	19.86 Deg	16.37 Deg
2072.1	2429.5		
3392.5	3027.8		
3372.6	3264.0		
5894.4	7929.4	1671.1 Pa	1699.6 Pa
3911.0	4790.7	19.11 Deg	17.31 Deg
4345.6	4567.9		
4655.6	4381.1		
4834.6	5085.7		
8273.3	7262.0	1867.7 Pa	2129.6 Pa
5315.1	5798.8	17.62 Deg	21.10 Deg
5181.9	4972.6		
5535.2	5460.7		
4704.2	4021.1		

TEST 22 SET 5

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Weight= 1735.0 N Volume= 112.6 Litres
 Density= 1570.7 Kg/M³ Weight Factor= 1.155

Normal Stress(Pa)		Shear Stress/Friction Angle	
272.3	272.0	822.5 Pa	665.7 Pa
1238.3	1287.3	19.06 Deg	16.14 Deg
2383.8	2654.8		
3974.6	3445.0		
4139.1	3943.9		
6516.0	10110.2	2017.7 Pa	2063.6 Pa
5259.8	5913.8	18.87 Deg	16.60 Deg
5635.6	5945.8		
5744.9	5704.7		
6106.8	6215.7		
8129.9	6900.5	1474.1 Pa	1720.1 Pa
4925.4	5749.2	19.10 Deg	23.40 Deg
3612.1	3268.9		
2862.9	2772.0		
1421.1	1150.2		

TEST 22 SET 6

Weight= 1730.6 N Volume= 111.4 Litres
 Density= 1583.6 Kg/M³ Weight Factor= 1.178

Normal Stress(Pa)		Shear Stress/Friction Angle	
277.6	277.3	841.7 Pa	681.4 Pa
1262.3	1338.9	18.46 Deg	15.52 Deg
2532.1	2826.2		
4254.0	3716.5		
4389.9	4228.2		
6392.6	10120.5	2094.8 Pa	2166.4 Pa
5725.8	6063.9	18.96 Deg	15.93 Deg
6088.7	6198.5		
6143.6	6105.8		
6051.3	6443.9		
7478.7	6609.3	1384.9 Pa	1605.6 Pa
4698.9	5448.6	19.80 Deg	23.34 Deg
2843.8	2915.7		
2481.9	2306.0		
1966.6	1203.3		

TEST 22 SET 7

Weight= 1711.9 N Volume= 110.2 Litres
 Density= 1583.5 Kg/M³ Weight Factor= 1.231

Normal Stress(Pa)		Shear Stress/Friction Angle	
386.8	217.3	872.8 Pa	712.1 Pa
1495.0	1427.2	17.29 Deg	15.01 Deg
2816.8	3039.4		
4657.3	4036.7		
4791.5	4684.2		
6354.5	10266.2	2228.9 Pa	2323.5 Pa
6281.3	6970.6	19.38 Deg	17.16 Deg
6833.2	6957.5		
6311.0	6502.3		
5986.9	6470.7		
3892.6	5547.7	1279.0 Pa	1440.0 Pa
4372.3	4237.3	23.62 Deg	23.98 Deg
2627.8	2582.6		
2536.6	2409.8		
1371.0	1289.7		

TEST 22 SET 8

Weight= 1660.0 N Volume= 106.8 Litres
 Density= 1584.4 Kg/M³ Weight Factor= 1.254

Normal Stress(Pa)		Shear Stress/Friction Angle	
262.2	172.3	893.0 Pa	731.8 Pa
1404.3	1141.0	17.33 Deg	14.91 Deg
2936.3	3098.0		
4926.9	4301.6		
4935.8	5094.4		
5978.8	8529.3		
5704.5	6535.1	2165.9 Pa	2304.3 Pa
6598.3	5428.7	19.47 Deg	19.74 Deg
7017.4	4614.6		
5547.5	6403.8		
5259.4	4863.0		
3816.7	4622.7	1244.1 Pa	1407.8 Pa
2774.1	2721.2	21.18 Deg	23.69 Deg
2614.6	2594.6		
1484.8	1314.6		

TEST 22 SET 9

Weight= 1400.8 N Volume= 90.2 Litres
 Density= 1583.1 Kg/M³ Weight Factor= 1.205

Normal Stress(Pa)		Shear Stress/Friction Angle	
315.6	141.8	656.9 Pa	540.4 Pa
688.8	630.2	25.50 Deg	21.78 Deg
1211.8	1263.4		
1692.7	1736.6		
2844.7	2884.1		
5232.6	5689.6		
5217.3	5328.5	1988.2 Pa	2011.8 Pa
5823.6	7093.9	20.56 Deg	20.03 Deg
5456.8	4997.9		
4897.5	4751.6		
3486.3	4073.8		
4302.9	4440.5	1109.7 Pa	1237.6 Pa
3032.3	2585.5	20.98 Deg	22.53 Deg
2483.6	2658.5		
1426.3	1325.9		

TEST 22 SET 10

Weight= 1203.4 N Volume= 76.4 Litres
 Density= 1605.6 Kg/M³ Weight Factor= 1.187

Normal Stress(Pa)		Shear Stress/Friction Angle	
62.1	-23.3	372.9 Pa	329.0 Pa
339.2	458.7	24.74 Deg	23.19 Deg
884.7	1050.5		
986.5	914.0		
1720.1	1466.6		
1099.7	1307.3	1722.3 Pa	1751.9 Pa
6544.0	5283.1	20.69 Deg	21.24 Deg
4987.8	5921.6		
5320.8	5214.5		
5597.3	5549.6		
4247.6	2915.1	1114.6 Pa	1153.1 Pa
3510.3	5394.0	20.97 Deg	22.18 Deg
2986.0	2462.1		
2445.7	2585.2		
1321.9	1243.5		

TEST 22 SET 11

Weight= 721.4 N Volume= 46.6 Litres
 Density= 1576.6 Kg/M³ Weight Factor= 1.112

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	-21.8	43.3 Pa	53.6 Pa
26.5	50.6	0.00 Deg	0.00 Deg
38.6	0.0		
31.9	27.6		
230.3	196.3		
559.4	525.0	910.1 Pa	892.6 Pa
1183.5	774.6	25.13 Deg	23.28 Deg
1499.8	1083.8		
2641.3	1592.3		
3699.9	5744.6		
3653.4	3308.3	979.8 Pa	1007.7 Pa
3727.7	3858.5	20.07 Deg	21.60 Deg
2770.0	2385.9		
2163.2	2238.7		
1298.8	1136.2		

TEST 23 SET 2

Weight= 227.2 N Volume= 13.4 Litres
 Density= 1723.4 Kg/M³ Weight Factor= 1.432

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	-28.1	-11.9 Pa	-10.4 Pa
-68.2	0.0	0.00 Deg	0.00 Deg
-24.8	0.0		
0.0	35.6		
59.3	0.0		
37.9	45.1	21.3 Pa	7.3 Pa
0.0	0.0	0.00 Deg	0.00 Deg
-64.4	0.0		
-31.8	0.0		
-30.2	-43.8		
456.5	581.0	478.3 Pa	589.5 Pa
1930.7	1232.7	15.80 Deg	21.28 Deg
2147.8	1519.6		
2288.5	2488.3		
2393.2	1913.5		

TEST 23 SET 3

Weight= 854.8 N Volume= 52.6 Litres
 Density= 1655.4 Kg/M³ Weight Factor= 1.241

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	0.0	-17.2 Pa	9.0 Pa
-29.6	-28.2	0.00 Deg	0.00 Deg
-21.5	-28.9		
0.0	30.8		
0.0	24.3		
558.5	546.7	763.2 Pa	706.0 Pa
1650.5	1427.9	22.29 Deg	20.78 Deg
2119.5	2128.3		
2230.8	2236.0		
2847.8	3034.0		
4502.0	4753.7	1413.1 Pa	1619.6 Pa
3729.6	3771.0	20.18 Deg	23.97 Deg
3500.5	2866.8		
3763.9	3729.5		
3599.2	2957.8		

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TEST 23 SET 4

Weight= 1808.9 N Volume= 111.8 Litres
 Density= 1649.3 Kg/M³ Weight Factor= 1.338

Normal Stress(Pa)		Shear Stress/Friction Angle	
525.7	420.1	952.6 Pa	709.7 Pa
1466.2	1338.8	23.01 Deg	17.55 Deg
2227.4	2712.4		
3644.5	3258.6		
3491.7	3622.9		
4003.9	3454.1	1951.8 Pa	1897.0 Pa
4661.0	4458.4	23.25 Deg	23.28 Deg
4632.3	4799.8		
4455.8	4460.0		
4907.9	5031.3		
6857.3	7117.9	2171.9 Pa	2486.1 Pa
6241.3	6011.1	20.31 Deg	24.31 Deg
5510.3	4322.6		
5485.2	5424.9		
5155.5	4452.3		

TEST 23 SET 5

Weight= 1795.7 N Volume= 110.8 Litres
 Density= 1652.0 Kg/M³ Weight Factor= 1.295

Normal Stress(Pa)		Shear Stress/Friction Angle	
576.5	431.9	1138.0 Pa	836.7 Pa
1604.0	1472.3	22.97 Deg	17.65 Deg
2694.5	3047.4		
4195.2	3893.7		
4451.8	4420.8		
5280.6	4484.1	2435.1 Pa	2395.3 Pa
5889.0	5569.7	22.21 Deg	22.97 Deg
6346.0	5957.8		
6238.2	5563.1		
6190.6	6769.2		
8636.5	7734.8	1574.0 Pa	1746.0 Pa
4105.3	5329.6	20.87 Deg	23.73 Deg
3225.9	2626.0		
2579.2	2535.7		
1502.8	1289.2		

TEST 23 SET 6

Weight= 1782.4 N Volume= 109.2 Litres
 Density= 1663.9 Kg/M³ Weight Factor= 1.315

Normal Stress(Pa)		Shear Stress/Friction Angle	
585.3	464.3	1148.1 Pa	849.5 Pa
1659.7	1584.5	22.26 Deg	16.93 Deg
2826.8	3151.1		
4372.2	4118.4		
4683.0	4746.1		
5778.9	4883.5	2524.6 Pa	2448.7 Pa
6614.8	6252.0	20.88 Deg	20.93 Deg
7329.4	7073.8		
7963.0	6654.2		
6561.8	7394.9		
4835.4	4296.8	1425.1 Pa	1568.1 Pa
4335.6	4491.3	22.76 Deg	26.68 Deg
3840.2	3038.0		
2374.9	2610.6		
1678.3	1343.3		

TEST 23 SET 7

Weight= 1769.2 N Volume= 108.2 Litres
 Density= 1666.8 Kg/M³ Weight Factor= 1.331

Normal Stress(Pa)		Shear Stress/Friction Angle	
662.3	417.8	1155.0 Pa	860.1 Pa
1680.4	1604.2	21.81 Deg	16.80 Deg
2895.1	3287.4		
4464.9	4233.8		
4824.1	4831.3		
5952.6	5028.2	2562.7 Pa	2502.9 Pa
6665.0	6652.4	20.76 Deg	21.11 Deg
7570.3	7213.8		
7357.8	7000.0		
6559.5	6917.4		
2970.0	2910.2	1379.9 Pa	1524.1 Pa
4510.8	4905.3	24.72 Deg	27.66 Deg
3755.7	3138.6		
2620.3	2790.0		
1575.6	1290.3		

TEST 23 SET 8

Weight= 1678.8 N Volume= 103.0 Litres
 Density= 1661.4 Kg/M³ Weight Factor= 1.307

Normal Stress(Pa)		Shear Stress/Friction Angle	
479.3	230.8	1148.9 Pa	847.9 Pa
996.5	1010.7	23.85 Deg	17.83 Deg
2742.8	2954.6		
4272.7	4190.7		
4548.4	4847.6		
5365.6	5226.4	2358.0 Pa	2318.7 Pa
5597.3	6533.6	21.83 Deg	21.13 Deg
6817.9	7084.9		
6704.0	6423.0		
5286.0	5275.2		
3429.8	4861.9	1313.9 Pa	1451.0 Pa
4739.9	4933.5	23.06 Deg	23.56 Deg
3489.2	2774.3		
2634.0	2848.3		
1517.1	1301.5		

TEST 23 SET 9

Weight= 1481.3 N Volume= 92.2 Litres
 Density= 1637.8 Kg/M³ Weight Factor= 1.239

Normal Stress(Pa)		Shear Stress/Friction Angle	
454.4	243.2	827.3 Pa	603.6 Pa
797.1	845.5	28.94 Deg	22.34 Deg
1289.4	1386.1		
1954.3	1878.7		
2874.7	2917.9		
5053.9	4408.6	2109.5 Pa	2151.1 Pa
6505.6	6043.9	20.21 Deg	20.95 Deg
6435.8	6813.4		
5970.4	6028.1		
5089.6	5342.0		
4679.9	2989.0	1245.7 Pa	1285.4 Pa
3725.8	4267.3	21.68 Deg	25.39 Deg
3150.4	2834.7		
2525.9	2495.2		
1582.1	1298.8		

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TEST 23 SET 10

Weight= 1251.8 N Volume= 78.8 Litres
 Density= 1632.3 Kg/M³ Weight Factor= 1.189

Normal Stress(Pa)		Shear Stress/Friction Angle	
62.3	186.7		
453.2	540.9	466.4 Pa	378.5 Pa
907.3	914.4	26.58 Deg	23.07 Deg
920.6	1152.6		
2192.0	1633.3		
1480.1	2845.3		
5753.6	5511.4	1829.4 Pa	1783.0 Pa
5293.4	5564.3	21.61 Deg	20.89 Deg
5913.9	4609.9		
5384.8	5271.5		
4840.6	5119.9		
3531.9	3742.9	1135.9 Pa	1227.4 Pa
2724.8	2804.2	20.97 Deg	21.77 Deg
2175.9	2460.0		
1435.3	1184.0		

TEST 23 SET 11

Weight= 719.2 N Volume= 47.8 Litres
 Density= 1532.4 Kg/M³ Weight Factor= 1.069

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	21.0	53.5 Pa	38.6 Pa
0.0	48.6	0.00 Deg	0.00 Deg
55.6	0.0		
0.0	55.1		
243.5	272.7		
622.8	538.5	930.6 Pa	958.6 Pa
1086.2	809.6	23.38 Deg	27.36 Deg
1345.8	1151.9		
2919.2	2903.5		
4525.5	3693.0		
3905.8	3036.2	950.3 Pa	984.9 Pa
3058.1	4285.0	19.89 Deg	21.67 Deg
2799.1	2117.5		
2129.3	2122.9		
1265.5	1092.4		

TEST 24 SET 2

Weight= 211.8 N Volume= 13.4 Litres
 Density= 1606.2 Kg/M³ Weight Factor= 1.374

Normal Stress(Pa)		Shear Stress/Friction Angle	
36.0	-27.0	-11.5 Pa	0.0° Pa
65.5	-62.5	0.00 Deg	0.00 Deg
47.7	-32.0		
39.4	0.0		
0.0	53.9		
-36.4	-43.3	17.0 Pa	10.5 Pa
-33.2	-41.6	0.00 Deg	0.00 Deg
30.9	-53.6		
30.5	0.0		
28.9	0.0		
235.9	371.8	394.0 Pa	558.9 Pa
1302.2	1072.2	14.52 Deg	19.94° Deg
2166.2	1588.0		
2100.9	2539.8		
2041.6	2268.6		

TEST 24 SET 3

Weight= 829.5 N Volume= 54.2 Litres
 Density= 1558.9 Kg/M³ Weight Factor= 1.117

Normal Stress(Pa)		Shear Stress/Friction Angle	
58.5	0.0	-21.7 Pa	-10.8 Pa
26.6	-50.8	0.00 Deg	0.00 Deg
38.7	0.0		
32.0	27.7		
-23.1	43.8		
502.6	527.2	650.9 Pa	638.3 Pa
1539.5	1521.9	19.87 Deg	18.97 Deg
2058.1	2133.1		
2230.8	2315.6		
2774.6	2901.2		
5502.7	5395.5	1221.9 Pa	1488.5 Pa
3437.9	3874.4	17.47 Deg	20.34 Deg
3632.9	3343.6		
3697.7	3910.8		
2928.3	3334.8		

TEST 24 SET 4

Weight= 1814.4 N Volume= 116.0 Litres
 Density= 1594.5 Kg/M³ Weight Factor= 1.224

Normal Stress(Pa)		Shear Stress/Friction Angle	
705.0	504.2	840.4 Pa	646.0 Pa
1632.2	1307.8	18.80 Deg	16.89 Deg
2340.0	2394.8		
3929.1	3223.1		
3775.8	3337.0		
4309.3	4044.5	1769.6 Pa	1768.9 Pa
4647.1	4966.4	20.38 Deg	20.41 Deg
4868.7	4961.7		
4889.5	4743.1		
5128.1	5199.4		
9330.9	8880.8	1953.9 Pa	2365.5 Pa
5573.5	6253.9	17.56 Deg	20.60 Deg
5474.3	4991.5		
5611.1	5804.5		
4430.4	5097.3		

TEST 24 SET 5

Weight= 1810.0 N Volume= 115.8 Litres
 Density= 1593.3 Kg/M³ Weight Factor= 1.203

Normal Stress(Pa)		Shear Stress/Friction Angle	
756.1	495.6	936.7 Pa	719.2 Pa
1719.3	1477.2	18.61 Deg	16.79 Deg
2690.9	2522.6		
4518.1	3676.9		
4359.9	3870.8		
5096.8	4771.6	2044.3 Pa	2060.2 Pa
5674.5	6121.6	19.54 Deg	19.22 Deg
6057.6	6003.7		
5848.6	5940.3		
6181.6	6840.1		
9380.0	9707.2	1667.9 Pa	2032.8 Pa
5216.5	6569.1	19.66 Deg	21.76 Deg
3761.3	4113.1		
2981.1	3351.0		
1507.7	1418.3		

TEST 24 SET 6

Weight= 1803.4 N Volume= 114.6 Litres
 Density= 1604.1 Kg/M³ Weight Factor= 1.222

Normal Stress(Pa)		Shear Stress/Friction Angle	
800.3	527.6	989.2 Pa	757.3 Pa
1805.2	1528.7	18.38 Deg	16.40 Deg
2903.7	2762.5		
4801.0	3948.7		
4708.4	4220.8		
5567.1	5117.6		
6061.4	6664.3	2210.7 Pa	2233.1 Pa
6429.7	6529.1	19.73 Deg	19.64 Deg
6214.0	6337.5		
6589.9	6875.3		
8661.6	8678.5		
4610.0	5786.9	1514.7 Pa	1807.7 Pa
2796.4	3285.7	19.94 Deg	22.31 Deg
2689.3	2663.2		
1532.0	1249.0		

TEST 24 SET 7

Weight= 1790.2 N Volume= 113.6 Litres
 Density= 1606.4 Kg/M³ Weight Factor= 1.262

Normal Stress(Pa)		Shear Stress/Friction Angle	
760.0	519.8	1035.1 Pa	787.9 Pa
1893.3	1692.7	17.65 Deg	15.60 Deg
3194.1	3027.9		
5317.3	4389.3		
5252.0	4629.0		
6180.7	5719.3		
6561.8	7299.3	2341.4 Pa	2375.6 Pa
6892.0	7182.1	19.14 Deg	19.34 Deg
6778.2	6853.1		
7307.0	7096.7		
4300.1	6341.7		
4459.6	5735.7	1964.3 Pa	1628.4 Pa
3175.1	2707.3	23.37 Deg	23.48 Deg
2512.9	2575.0		
1493.5	1322.2		

TEST 24 SET 8

Weight= 1750.5 N Volume= 111.2 Litres
 Density= 1604.6 Kg/M³ Weight Factor= 1.297

Normal Stress(Pa)		Shear Stress/Friction Angle	
781.3	407.2	1057.0 Pa	803.7 Pa
2039.2	1740.3	16.97 Deg	15.23 Deg
3463.7	3203.6		
5466.6	4609.3		
5695.0	4862.6		
6594.7	5920.8	2294.5 Pa	2485.2 Pa
7153.9	7150.6	18.93 Deg	20.94 Deg
7406.4	6675.8		
6479.0	6469.2		
6037.1	6503.0		
5788.5	3742.3	1310.5 Pa	1495.0 Pa
4301.2	3907.9	20.58 Deg	27.41 Deg
3099.4	3180.9		
2613.6	2468.4		
1535.4	1325.4		

TEST 24 SET 9

Weight= 1650.1 N Volume= 104.0 Litres
 Density= 1617.4 Kg/M³ Weight Factor= 1.316

Normal Stress(Pa)		Shear Stress/Friction Angle	
620.6	387.4	1083.8 Pa	806.2 Pa
1066.1	1047.7	20.71 Deg	18.23 Deg
2967.4	2453.8		
4793.1	3925.5		
4934.5	4442.4		
5228.7	6381.8	2194.9 Pa	2294.9 Pa
6910.1	8094.4	21.18 Deg	20.41 Deg
6747.1	7699.0		
6166.3	6175.4		
3936.7	3980.4		
4680.3	4272.7	1316.3 Pa	1467.8 Pa
4485.2	5347.1	21.80	24.65 Deg
3145.5	2886.8		
2682.9	2287.3		
1558.2	1414.1		

TEST 24 SET 10

Weight= 1449.3 N Volume= 92.4 Litres
 Density= 1598.9 Kg/M³ Weight Factor= 1.235

Normal Stress(Pa)		Shear Stress/Friction Angle	
549.7	314.9	786.4 Pa	547.8 Pa
852.8	786.1	24.69 Deg	21.75 Deg
1434.3	1208.1		
1875.9	1748.7		
3605.0	2712.8		
4609.4	4624.8	2049.4 Pa	2067.6 Pa
6151.9	6394.4	20.67 Deg	20.24 Deg
6216.6	7797.9		
5097.7	5273.2		
5355.9	4642.0		
4298.5	4507.9	1192.3 Pa	1311.5 Pa
3846.4	4715.7	21.94 Deg	23.35 Deg
2897.2	2270.6		
2344.5	2519.6		
1461.3	1261.5		

TEST 24 SET 11

Weight= 1216.6 N Volume= 78.4 Litres
 Density= 1581.9 Kg/M³ Weight Factor= 1.205

Normal Stress(Pa)		Shear Stress/Friction Angle	
63.1	47.3	422.4 Pa	325.5 Pa
459.4	520.8	26.3 Deg	20.91 Deg
856.9	954.9		
933.0	1018.4		
1872.2	1702.7		
1563.9	1290.1	1737.6 Pa	1736.8 Pa
4608.8	5293.8	22.78 Deg	21.13 Deg
5175.3	6203.4		
5860.0	5922.1		
4239.1	4753.2		
4610.5	4428.4	1151.3 Pa	1247.1 Pa
4062.8	4766.2	20.61 Deg	22.48 Deg
2818.8	2529.5		
2372.8	2260.5		
1454.7	1200.0		

C2-27

TEST 24 SET 12

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Weight= 604.4 N Volume= 38.6 Litres

Density= 1594.6 Kg/M³ Weight Factor= 1.185

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Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	23.2	16.5 Pa	57.1 Pa
0.0	26.9	0.00 Deg	0.00 Deg
61.6	55.2		
101.9	29.4		
49.1	46.5		
62.7	261.0	511.2 Pa	665.1 Pa
831.0	610.0	30.02 Deg	36.39 Deg
878.8	1062.3		
1209.7	935.9		
2245.2	1629.5		
3863.0	4245.3	2 Pa	1082.5 Pa
3582.7	3313.9	34 Deg	21.69 Deg
2649.8	2513.9		
2057.6	2319.6		
1374.7	1210.4		

TEST 26 SET 2

Weight= 249.3 N Volume= 15.4 Litres
 Density= 1645.8 Kg/M³ Weight Factor= 1.055

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	0.0	0.0 Pa	0.0 Pa
0.0	37.6	0.00 Deg	0.00 Deg
0.0	-38.6		
0.0	41.1		
0.0	0.0		
0.0	0.0		
-40.0	0.0	41.1 Pa	8.4 Pa
0.0	64.5	0.00 Deg	0.00 Deg
0.0	-81.7		
-34.9	0.0		
446.4	708.9	422.3 Pa	660.6 Pa
1658.7	1469.3	13.00 Deg	20.57 Deg
2566.6	1951.5		
2453.4	2419.5		
2305.0	2365.1		

TEST 26 SET 3

Weight= 858.1 N Volume= 55.2 Litres
 Density= 1583.6 Kg/M³ Weight Factor= 1.264

Normal Stress(Pa)		Shear Stress/Friction Angle	
-39.1	0.0	-3.5 Pa	12.2 Pa
0.0	0.0	0.00 Deg	0.00 Deg
0.0	29.5		
0.0	0.0		
-26.2	-24.8		
636.2	676.7	872.0 Pa	764.6 Pa
1712.8	1761.8	23.10 Deg	20.60 Deg
2359.2	2465.0		
2498.2	2497.5		
3115.6	2937.7		
3503.4	3705.0	1264.0 Pa	1631.8 Pa
3409.6	3945.5	19.55 Deg	24.58 Deg
3664.1	3428.7		
3953.3	3696.5		
3945.6	3147.1		

TEST 26 SET 4

Weight= 1871.8 N Volume= 120.6 Litres
 Density= 1582.1 Kg/M³ Weight Factor= 1.334

Normal Stress (Pa)		Shear Stress/Friction Angle	
1293.0	863.9	1053.8 Pa	820.2 Pa
2224.8	1668.8	19.47 Deg	17.14 Deg
2868.9	3357.6		
4169.7	3779.9		
4421.3	3822.1		
4734.5	4326.4		
4906.0	5132.8	2062.1 Pa	2027.3 Pa
5249.1	5306.4	22.08 Deg	22.52 Deg
4917.1	4809.8		
5563.8	5057.9		
5987.2	6285.7		
5924.1	5886.4	2035.9 Pa	2452.2 Pa
5426.8	5002.5	20.46 Deg	24.52 Deg
5778.7	5225.6		
4800.2	4474.7		

TEST 26 SET 5

Weight= 1860.8 N Volume= 120.6 Litres
 Density= 1572.8 Kg/M³ Weight Factor= 1.232

Normal Stress (Pa)		Shear Stress/Friction Angle	
1419.4	942.5	1198.9 Pa	899.8 Pa
2405.9	1820.7	19.87 Deg	16.92 Deg
3161.1	3731.0		
4626.2	4101.6		
5025.4	4374.3		
5544.9	5196.0		
6078.4	6305.4	2398.9 Pa	2381.8 Pa
6784.0	6531.6	20.59 Deg	21.40 Deg
6508.1	5960.8		
7055.9	6589.6		
6161.4	6219.1		
5116.9	6196.1	1484.2 Pa	1750.6 Pa
3851.3	3950.1	20.73 Deg	21.44 Deg
2824.2	3669.0		
1658.2	2355.9		

TEST 26 SET 6

Weight= 1850.8 N Volume= 119.2 Litres
 Density= 1582.8 Kg/M³ Weight Factor= 1.221

Normal Stress(Pa)		Shear Stress/Friction Angle	
1406.9	934.2	1232.6 Pa	909.6 Pa
2472.0	1887.9	17.49 Deg	16.39 Deg
3239.1	3868.8		
7595.8	4338.6		
5208.7	4623.2		
5754.7	5303.9	2438.4 Pa	2367.1 Pa
6408.9	6619.7	20.18 Deg	20.07 Deg
7136.0	7045.3		
6830.3	6481.0		
7148.1	7166.1		
6316.7	5779.1	1355.6 Pa	1563.5 Pa
4916.2	5747.5	20.35 Deg	20.65 Deg
3196.7	3527.4		
2403.5	3266.3		
1331.9	2367.1		

TEST 26 SET 7

Weight= 1838.7 N Volume= 117.8 Litres
 Density= 1591.1 Kg/M³ Weight Factor= 1.227

Normal Stress(Pa)		Shear Stress/Friction Angle	
1446.2	914.9	1255.9 Pa	926.0 Pa
2543.1	1925.5	19.52 Deg	16.19 Deg
3340.8	3974.3		
4995.9	4513.2		
5438.6	4815.3		
5784.1	5253.7	2383.9 Pa	2413.5 Pa
6411.9	6765.0	20.42 Deg	20.65 Deg
7006.9	6937.7		
6647.2	6150.5		
6357.5	7127.6		
4543.5	6278.8	1281.8 Pa	1506.8 Pa
4807.1	7526.3	22.43 Deg	17.39 Deg
2994.6	4803.4		
2046.3	3519.8		
1253.2	2250.6		

TEST 26 SET 8

Weight= 1827.7 N Volume= 117.4 Litres
 Density= 1586.9 Kg/M³ Weight Factor= 1.256

Normal Stress(Pa)		Shear Stress/Friction Angle	
1480.0	936.3	1295.7 Pa	959.8 Pa
2662.3	1970.4	19.64 Deg	16.16 Deg
3484.1	4184.2		
5220.5	4681.0		
5409.6	5001.7		
5719.6	5574.1	2383.5 Pa	2418.8 Pa
6409.7	7075.1	21.37 Deg	20.84 Deg
7057.6	7099.7		
6300.6	6511.2		
3315.9	5950.4		
4464.9	6057.4	1318.3 Pa	1542.0 Pa
4621.9	7803.4	24.10 Deg	18.16 Deg
2649.6	4678.6		
1948.6	3157.8		
1136.7	2171.5		

TEST 26 SET 9

Weight= 1816.6 N Volume= 116.8 Litres
 Density= 1585.5 Kg/M³ Weight Factor= 1.328

Normal Stress(Pa)		Shear Stress/Friction Angle	
1565.7	964.4	1374.5 Pa	1005.8 Pa
2816.4	2114.7	19.40 Deg	15.76 Deg
3708.8	4457.4		
5637.0	5051.0		
5887.8	5447.6		
6085.9	5896.7	2547.9 Pa	2552.1 Pa
7005.7	7766.3	21.05 Deg	21.02 Deg
7764.8	7614.3		
7078.2	6855.3		
5623.6	5685.7		
4234.7	4731.2	1338.8 Pa	1567.9 Pa
3437.1	4538.5	27.05 Deg	28.39 Deg
2127.5	2192.8		
1999.9	1905.3		
1233.4	1113.8		

TEST 26 SET 10

Weight= 1804.5 N Volume= 116.4 Litres
 Density= 1580.3 Kg/M³ Weight Factor= 1.378

Normal Stress(Pa)		Shear Stress/Friction Angle	
1588.1	973.4	1425.8 Pa 19.27 Deg	1056.6 Pa 16.18 Deg
2954.4	2162.4		
3919.1	4623.9		
5847.6	5171.2		
6193.4	5515.9		
6459.2	6203.8	2608.9 Pa 22.25 Deg	2633.5 Pa 22.54 Deg
7234.1	7847.8		
7404.3	7468.9		
6302.4	6124.7		
4904.9	4718.5		
4156.4	4473.1	1367.0 Pa 28.71 Deg	1616.1 Pa 31.29 Deg
3013.1	3670.1		
2031.9	1852.3		
1978.9	1900.4		
1183.5	1263.7		

TEST 26 SET 11

Weight= 1795.7 N Volume= 115.6 Litres
 Density= 1583.4 Kg/M³ Weight Factor= 1.418

Normal Stress(Pa)		Shear Stress/Friction Angle	
1559.2	917.8	1486.3 Pa 19.78 Deg	1097.1 Pa 16.30 Deg
2971.3	2224.1		
4031.0	4756.0		
6014.7	5319.0		
6223.6	5784.8		
6230.9	5979.5	2655.3 Pa 23.26 Deg	2683.6 Pa 23.41 Deg
7235.1	7857.3		
7074.1	7737.6		
6010.5	5874.7		
4746.6	4230.0		
3545.2	3482.6	1406.1 Pa 31.00 Deg	1658.7 Pa 34.96 Deg
2815.1	3275.8		
2306.1	1838.4		
1740.0	1993.8		
1250.2	1262.7		

TEST 26 SET 12

Weight= 1783.6 N Volume= 114.6 Litres
 Density= 1586.5 Kg/M³ Weight Factor= 1.426

Normal Stress(Pa)		Shear Stress/Friction Angle	
1494.2	923.5	1487.6 Pa	1093.6 Pa
2989.9	2270.5	19.80 Deg	15.80 Deg
4056.2	4818.9		
5970.4	5493.9		
6292.0	6044.8		
6534.2	5882.1	2675.3 Pa	2689.3 Pa
7038.7	7258.3	23.35 Deg	23.87 Deg
7342.7	6840.4		
5889.7	5740.3		
4565.9	5101.6		
3182.6	3118.5	1381.0 Pa	1626.0 Pa
2572.8	3146.2	31.88 Deg	35.59 Deg
2103.0	2018.0		
1982.7	1848.9		
1258.0	1270.6		

TEST 26 SET 13

Weight= 1760.4 N Volume= 113.2 Litres
 Density= 1585.2 Kg/M³ Weight Factor= 1.385

Normal Stress(Pa)		Shear Stress/Friction Angle	
1088.5	733.9	1464.1 Pa	1072.1 Pa
2805.0	2142.3	21.12 Deg	16.71 Deg
3795.6	4680.5		
5600.4	5164.0		
5853.1	5436.3		
5979.7	5320.7	2598.4 Pa	2590.8 Pa
6333.9	6504.3	23.59 Deg	23.94 Deg
6509.0	6103.9		
5751.3	4959.8		
5339.3	6352.7		
4212.3	3903.3	1341.3 Pa	1610.6 Pa
2978.5	3838.5	26.95 Deg	31.76 Deg
2465.2	2254.1		
2213.9	1986.9		
1254.0	1088.9		

TEST 26 SET 14

Weight= 1669.9 N Volume= 106.0 Litres
 Density= 1605.9 Kg/M³ Weight Factor= 1.316

Normal Stress(Pa)		Shear Stress/Friction Angle	
999.3	592.7	1346.6 Pa	996.1 Pa
1441.6	1107.0	23.94 Deg	19.32 Deg
2692.0	3433.4		
4564.2	4152.2		
5367.8	4956.2		
6445.3	5218.6	2369.9 Pa	2330.3 Pa
7001.8	6535.7	21.12 Deg	22.22 Deg
6654.7	6822.7		
5578.8	6204.5		
5181.4	4384.0		
4000.3	3677.3	1228.9 Pa	1486.7 Pa
3610.7	4388.6	23.94 Deg	28.56 Deg
2608.7	2606.0		
2437.7	1995.8		
1252.0	1172.0		

APPENDIX D1

RAW DATA - BIN 2

D1-1

TEST 27				SET 1		microvolts			
1	0	9	-25	17	95	25	-3987	33	-25
2	-15	10	12	18	-3	26	-6	34	-30
3	3	11	-4	19	9	27	47	35	0
4	-10	12	-8	20	0	28	5	36	71
5	-28	13	-1459	21	29	29	0	37	109
6	28	14	-6	22	12	30	-35	38	0
7	57	15	-9	23	-10	31	22		
8	240	16	6	24	-13	32	0		

TEST 27				SET 2		microvolts			
1	0	9	120	17	306	25	-3849	33	141
2	-9	10	170	18	177	26	82	34	136
3	20	11	150	19	570	27	168	35	149
4	30	12	182	20	4	28	98	36	199
5	9	13	-909	21	48	29	143	37	828
6	92	14	161	22	57	30	96	38	1337
7	212	15	233	23	31	31	519		
8	356	16	196	24	43	32	189		

Surface Heights mm

0 -600 620 690 745 685 620 -600 0

TEST 27				SET 3		microvolts			
1	0	9	174	17	207	25	-3816	33	161
2	-12	10	237	18	49	26	112	34	94
3	21	11	216	19	484	27	211	35	76
4	42	12	253	20	1	28	134	36	112
5	22	13	-751	21	49	29	193	37	696
6	115	14	193	22	63	30	129	38	1330
7	242	15	227	23	47	31	681		
8	395	16	135	24	68	32	204		

Surface Heights mm

0 -600 620 690 745 685 620 -600 0

TEST 27			SET 4			microvolts			
1	0	9	186	17	185	25	-3804	33	154
2	-13	10	245	18	43	26	114	34	67
3	28	11	221	19	453	27	215	35	68
4	48	12	252	20	0	28	139	36	111
5	26	13	-730	21	48	29	198	37	651
6	123	14	174	22	67	30	128	38	1326
7	254	15	210	23	54	31	701		
8	399	16	116	24	77	32	194		

Surface Heights mm

0 -595 615 685 740 680 615 -595 0

TEST 27			SET 5			microvolts			
1	0	9	191	17	177	25	-3792	33	104
2	-14	10	242	18	46	26	118	34	66
3	26	11	210	19	423	27	227	35	75
4	56	12	239	20	0	28	144	36	111
5	31	13	712	21	51	29	202	37	504
6	131	14	127	22	71	30	124	38	1311
7	267	15	166	23	61	31	717		
8	410	16	117	24	83	32	184		

Surface Heights mm

0 -595 610 675 730 675 615 -595 0

TEST 27			SET 6			microvolts			
1	0	9	188	17	178	25	-3790	33	109
2	-15	10	242	18	44	26	129	34	64
3	18	11	194	19	397	27	221	35	67
4	53	12	219	20	0	28	124	36	111
5	33	13	-746	21	41	29	182	37	570
6	140	14	95	22	71	30	135	38	1262
7	268	15	166	23	63	31	690		
8	410	16	98	24	88	32	142		

Surface Heights mm

0 -595 605 645 700 645 605 -595 0

DI-3

TEST 27				SET 7				microvolts		
1	0	9	145	17	173	25	-3876	33	97	
2	-14	10	234	18	42	26	80	34	68	
3	6	11	217	19	387	27	190	35	62	
4	8	12	192	20	0	28	135	36	111	
5	-5	13	-833	21	31	29	187	37	552	
6	98	14	140	22	26	30	67	38	1102	
7	189	15	143	23	15	31	613			
8	367	16	100	24	47	32	166			

Surface Heights mm

0 -585 590 570 605 570 585 -580 0

TEST 27				SET 8				microvolts		
1	0	9	121	17	177	25	-3927	33	115	
2	-13	10	171	18	42	26	61	34	58	
3	2	11	171	19	371	27	161	35	66	
4	-3	12	193	20	0	28	105	36	110	
5	-23	13	-909	21	27	29	138	37	526	
6	52	14	105	22	18	30	80	38	940	
7	124	15	155	23	0	31	543			
8	327	16	105	24	12	32	142			

Surface Heights mm

0 -540 540 530 500 520 540 -540 0

TEST 27				SET 9				microvolts		
1	0	9	18	17	176	25	-3960	33	100	
2	-13	10	89	18	42	26	10	34	70	
3	4	11	132	19	358	27	76	35	62	
4	-9	12	182	20	0	28	60	36	109	
5	-31	13	-1063	21	28	29	129	37	503	
6	33	14	132	22	13	30	91	38	728	
7	95	15	147	23	-9	31	420			
8	260	16	104	24	-8	32	145			

Surface Heights mm

0 -450 450 450 400 450 460 -450 0

D1-4

TEST 27				SET 10		microvolts			
1	0	9	0	17	179	25	-3967	33	101
2	-14	10	52	18	41	26	0	34	60
3	3	11	57	19	344	27	62	35	71
4	-10	12	150	20	0	28	25	36	111
5	-30	13	-1212	21	29	29	40	37	478
6	29	14	101	22	13	30	77	38	573
7	88	15	148	23	-9	31	288		
8	239	16	98	24	-12	32	125		
Surface Heights mm									
0	-385	395	385	370	385	395	-385	0	

TEST 28				SET 1		microvolts			
1	0	9	-23	17	97	25	-3969	33	-25
2	-13	10	12	18	-2	26	-5	34	-30
3	4	11	-4	19	9	27	45	35	0
4	-8	12	-8	20	0	28	4	36	70
5	-27	13	-1459	21	29	29	-1	37	115
6	30	14	-3	22	12	30	-32	38	-8
7	95	15	-10	23	-11	31	33		
8	248	16	6	24	-11	32	-2		

TEST 28				SET 2		microvolts			
1	0	9	127	17	307	25	-3832	33	140
2	-8	10	175	18	185	26	79	34	136
3	28	11	164	19	563	27	160	35	150
4	31	12	189	20	4	28	104	36	208
5	10	13	-897	21	50	29	135	37	845
6	92	14	167	22	51	30	82	38	1332
7	218	15	238	23	31	31	547		
8	370	16	187	24	47	32	183		

Surface Heights mm

0 -600 630 695 745 690 620 -600 0

TEST 28				SET 3		microvolts			
1	0	9	176	17	199	25	-3805	33	138
2	-10	10	232	18	48	26	111	34	85
3	24	11	226	19	466	27	198	35	72
4	42	12	260	20	1	28	132	36	112
5	21	13	-726	21	52	29	184	37	686
6	116	14	186	22	60	30	108	38	1324
7	246	15	211	23	47	31	727		
8	414	16	128	24	70	32	195		

Surface Heights mm

0 -600 630 695 745 690 620 -600 0

TEST 28				SET 4		microvolts			
1	0	9	178	17	187	25	-3792	33	137
2	-12	10	236	18	43	26	113	34	65
3	25	11	228	19	444	27	204	35	65
4	47	12	263	20	0	28	136	36	109
5	27	13	-708	21	51	29	180	37	647
6	124	14	169	22	65	30	110	38	1320
7	258	15	198	23	52	31	734		
8	418	16	113	24	74	32	187		

Surface Heights mm

0 -595 620 690 740 685 615 -595 0

TEST 28				SET 5		microvolts			
1	0	9	190	17	189	25	-3784	33	132
2	-13	10	246	18	45	26	124	34	66
3	30	11	223	19	421	27	216	35	63
4	56	12	242	20	1	28	144	36	112
5	37	13	-716	21	54	29	198	37	613
6	137	14	120	22	69	30	109	38	1310
7	275	15	197	23	55	31	760		
8	431	16	124	24	83	32	197		

Surface Heights mm

0 -590 620 680 730 675 615 -590 0

TEST 28				SET 6		microvolts			
1	0	9	197	17	186	25	-3777	33	128
2	-16	10	245	18	43	26	126	34	59
3	29	11	214	19	399	27	219	35	73
4	64	12	243	20	0	28	144	36	110
5	41	13	-725	21	51	29	194	37	575
6	143	14	122	22	73	30	114	38	1285
7	289	15	188	23	60	31	746		
8	423	16	90	24	89	32	129		

Surface Heights mm

0 -590 615 675 715 665 615 -590 0

TEST 28				SET 7		microvolts		
1	0	9	183	17	181	25	-3781	33 106
2	-15	10	232	18	44	26	125	34 62
3	19	11	215	19	397	27	223	35 61
4	60	12	221	20	0	28	142	36 109
5	39	13	-733	21	44	29	196	37 567
6	147	14	148	22	71	30	103	38 1263
7	286	15	127	23	62	31	735	
8	439	16	109	24	90	32	141	

Surface Heights mm

0 -590 610 650 700 640 615 -590 0

TEST 28				SET 8		microvolts		
1	0	9	152	17	186	25	-3870	33 106
2	-15	10	209	18	42	26	91	34 66
3	5	11	203	19	393	27	188	35 65
4	11	12	168	20	0	28	121	36 108
5	0	13	-798	21	33	29	174	37 555
6	102	14	116	22	30	30	122	38 1115
7	209	15	163	23	16	31	670	
8	384	16	84	24	53	32	170	

Surface Heights mm

0 -585 590 585 600 580 585 -580 0

TEST 28				SET 9		microvolts		
1	0	9	138	17	182	25	-3917	33 94
2	-14	10	185	18	43	26	72	34 66
3	2	11	161	19	382	27	170	35 65
4	0	12	209	20	0	28	118	36 110
5	-22	13	-866	21	29	29	146	37 540
6	62	14	137	22	22	30	121	38 976
7	142	15	148	23	2	31	614	
8	347	16	99	24	12	32	146	

Surface Heights mm

0 -560 560 530 510 530 550 -560 0

D1-8

	TEST 28				SET 10				microvolts	
1	0	9	17	17	181	25	-3955	33	114	
2	-14	10	98	18	40	26	13	34	53	
3	4	11	134	19	358	27	80	35	64	
4	-9	12	178	20	0	28	59	36	109	
5	-30	13	-1066	21	28	29	118	37	514	
6	32	14	116	22	12	30	102	38	717	
7	95	15	151	23	-11	31	427			
8	266	16	93	24	-6	32	122			

Surface Heights mm

0 -450 450 450 400 450 450 -460 0

	TEST 28				SET 11				microvolts	
1	0	9	0	17	188	25	-3964	33	87	
2	-13	10	50	18	43	26	-2	34	59	
3	4	11	44	19	342	27	63	35	64	
4	-10	12	122	20	0	28	23	36	108	
5	-30	13	-1215	21	28	29	44	37	490	
6	29	14	111	22	12	30	74	38	555	
7	89	15	147	23	-10	31	288			
8	250	16	100	24	-12	32	148			

Surface Heights mm

0 -400 400 380 350 380 400 -400 0

TEST 29				SET 1		microvolts			
1	0	9	-21	17	100	25	-3966	33	-25
2	-12	10	13	18	-1	26	-5	34	-31
3	4	11	-4	19	9	27	42	35	0
4	-10	12	-8	20	-4	28	3	36	70
5	-27	13	-1465	21	29	29	-2	37	120
6	29	14	-2	22	12	30	-34	38	59
7	81	15	-10	23	-11	31	39		
8	252	16	7	24	-13	32	-1		

TEST 29				SET 2		microvolts			
1	0	9	122	17	313	25	-3842	33	146
2	-12	10	161	18	183	26	85	34	148
3	28	11	163	19	549	27	165	35	159
4	26	12	186	20	-4	28	93	36	202
5	13	13	-914	21	47	29	141	37	846
6	89	14	157	22	51	30	100	38	1360
7	208	15	299	23	32	31	522		
8	373	16	196	24	49	32	202		

Surface Heights mm

0 -595 625 685 745 680 615 -590 0

TEST 29			SET 3		microvolts				
1	0	9	176	17	218	25	-3820	33	153
2	-12	10	217	18	50	26	114	34	101
3	29	11	230	19	479	27	205	35	76
4	38	12	263	20	-3	28	125	36	110
5	20	13	-770	21	42	29	191	37	710
6	109	14	202	22	52	30	146	38	1354
7	234	15	238	23	37	31	674		
8	413	16	135	24	67	32	217		

Surface Heights mm

0 -590 620 680 740 670 610 -590 0

01-10

TEST 29			SET 4			microvolts		
1	0	9	189	17	189	25	-3804	33 156
2	-13	10	231	18	42	26	123	34 59
3	25	11	239	19	452	27	208	35 66
4	43	12	264	20	-3	28	134	36 108
5	23	13	-737	21	45	29	196	37 662
6	115	14	191	22	61	30	134	38 1348
7	246	15	195	23	47	31	694	
8	416	16	128	24	76	32	207	

Surface Heights mm

0 -590 620 680 730 670 610 -590 0

TEST 29			SET 5			microvolts		
1	0	9	190	17	192	25	-3798	33 158
2	-14	10	236	18	44	26	121	34 59
3	25	11	225	19	438	27	206	35 74
4	49	12	252	20	-4	28	140	36 108
5	25	13	-731	21	44	29	200	37 635
6	119	14	183	22	61	30	139	38 1343
7	253	15	198	23	51	31	706	
8	421	16	112	24	79	32	191	

Surface Heights mm

0 -590 620 680 725 670 610 -590 0

TEST 29			SET 6			microvolts		
1	0	9	191	17	199	25	-3788	33 122
2	-13	10	244	18	42	26	125	34 83
3	28	11	239	19	425	27	214	35 63
4	55	12	266	20	-4	28	140	36 108
5	30	13	-725	21	48	29	195	37 605
6	124	14	153	22	67	30	142	38 1338
7	262	15	215	23	57	31	703	
8	419	16	113	24	88	32	183	

Surface Heights mm

0 -585 615 675 720 660 605 -585 0

D1-11

TEST 29				SET 7				microvolts	
1	0	9	198	17	189	25	-3786	33	113
2	14	10	248	18	42	26	127	34	61
3	28	11	234	19	410	27	218	35	71
4	57	12	243	20	-5	28	142	36	109
5	33	13	-723	21	48	29	198	37	598
6	127	14	123	22	67	30	124	38	1333
7	265	15	192	23	56	31	709		
8	425	16	110	24	88	32	181		

Surface Heights mm

0 -585 615 675 715 660 605 -585 0

		TEST 30		SET 1		microvolts			
1	0	9	-21	17	103	25	-3966	33	-23
2	-12	10	14	18	-1	26	0	34	-31
3	5	11	-3	19	7	27	33	35	0
4	-5	12	-7	20	-3	28	0	36	70
5	-25	13	-1462	21	29	29	0	37	128
6	29	14	-2	22	13	30	-30	38	14
7	77	15	-11	23	-8	31	58		
8	255	16	5	24	-10	32	0		

		TEST 30		SET 2		microvolts			
1	0	9	117	17	301	25	-3834	33	135
2	-6	10	159	18	188	26	85	34	134
3	22	11	158	19	56	27	152	35	143
4	26	12	187	20	0	28	88	36	198
5	8	13	-901	21	48	29	135	37	835
6	93	14	159	22	53	30	88	38	1343
7	208	15	221	23	31	31	548		
8	379	16	183	24	49	32	181		

Surface Heights mm

0 -600 630 690 745 690 630 -600 0

		TEST 30		SET 3		microvolts			
1	0	9	160	17	211	25	-3807	33	149
2	-7	10	214	18	49	26	115	34	78
3	25	11	209	19	480	27	188	35	74
4	38	12	238	20	-1	28	111	36	109
5	16	13	-756	21	46	29	176	37	715
6	109	14	171	22	56	30	120	38	1339
7	237	15	208	23	41	31	691		
8	415	16	126	24	61	32	184		

Surface Heights mm

0 -600 630 690 745 690 630 -600 0

	TEST 30			SET 4		microvolts		
1	0	9	171	17	186	25	-3796	33 145
2	-7	10	222	18	45	26	119	34 71
3	27	11	217	19	446	27	193	35 64
4	49	12	244	20	-2	28	120	36 108
5	25	13	-725	21	48	29	180	37 660
6	120	14	180	22	62	30	112	38 1332
7	249	15	191	23	48	31	721	
8	420	16	125	24	73	32	185	

Surface Heights mm

0 -590 620 680 735 680 620 -590 0

	TEST 30			SET 5		microvolts		
1	0	9	171	17	199	25	-3789	33 123
2	-10	10	231	18	47	26	124	34 72
3	28	11	218	19	424	27	198	35 64
4	51	12	229	20	-2	28	128	36 108
5	31	13	-718	21	49	29	186	37 634
6	128	14	133	22	67	30	119	38 1327
7	259	15	205	23	51	31	727	
8	430	16	102	24	83	32	193	

Surface Heights mm

0 -590 620 680 725 680 620 -590 0

	TEST 30			SET 6		microvolts		
1	0	9	173	17	189	25	-3781	33 114
2	-10	10	238	18	42	26	125	34 60
3	30	11	220	19	408	27	208	35 71
4	54	12	237	20	-2	28	135	36 110
5	31	13	-713	21	49	29	190	37 602
6	133	14	107	22	72	30	117	38 1319
7	268	15	190	23	55	31	734	
8	436	16	109	24	86	32	172	

Surface Heights mm

0 -590 620 675 720 675 620 -590 0

D1-14

	TEST 30			SET 7			microvolts		
1	0	9	172	17	190	25	-3779	33	132
2	-12	10	241	18	45	26	122	34	63
3	29	11	222	19	396	27	207	35	67
4	62	12	220	20	-3	28	136	36	107
5	38	13	-711	21	51	29	193	37	574
6	144	14	124	22	75	30	119	38	1306
7	274	15	166	23	59	31	731		
8	435	16	103	24	90	32	110		

Surface Heights mm

0 -585 615 670 710 670 615 -585 0

	TEST 30			SET 8			microvolts		
1	0	9	172	17	194	25	-3778	33	106
2	-14	10	248	18	44	26	126	34	69
3	27	11	233	19	389	27	207	35	61
4	63	12	219	20	-4	28	134	36	108
5	37	13	-713	21	49	29	196	37	566
6	145	14	137	22	74	30	108	38	1297
7	273	15	135	23	61	31	733		
8	434	16	102	24	92	32	145		

Surface Heights mm

0 -585 615 660 705 660 610 -580 0

TEST 31				SET 1		microvolts			
1	0	9	-24	17	154	25	-3964	33	-29
2	-6	10	13	18	-6	26	-7	34	-41
3	0	11	-10	19	7	27	21	35	-5
4	-17	12	-10	20	-8	28	-8	36	65
5	-31	13	-1469	21	30	29	-7	37	112
6	26	14	-5	22	5	30	-34	38	27
7	87	15	-24	23	-21	31	45		
8	357	16	-3	24	-20	32	-3		

TEST 31			SET 2			microvolts			
1	0	9	120	17	360	25	-3824	33	136
2	-18	10	161	18	190	26	72	34	133
3	13	11	159	19	566	27	144	35	149
4	18	12	184	20	-10	28	91	36	196
5	-3	13	-904	21	44	29	137	37	830
6	84	14	163	22	45	30	87	38	1344
7	208	15	227	23	23	31	540		
8	482	16	196	24	37	32	176		

Surface Heights mm

0 -600 625 690 745 685 625 -600 0

TEST 31			SET 3			microvolts			
1	0	9	172	17	251	25	-3796	33	142
2	-11	10	226	18	41	26	96	34	84
3	15	11	226	19	477	27	181	35	67
4	32	12	256	20	-7	28	121	36	105
5	10	13	-742	21	46	29	180	37	703
6	110	14	187	22	48	30	119	38	1334
7	240	15	220	23	32	31	706		
8	506	16	129	24	55	32	188		

Surface Heights mm

0 -600 625 690 745 685 625 -600 0

TEST 31			SET 4			microvolts		
1	0	9	175	17	235	25	-3786	33 130
2	-12	10	231	18	37	26	102	34 56
3	17	11	226	19	448	27	190	35 64
4	39	12	256	20	-8	28	125	36 106
5	16	13	-724	21	45	29	177	37 662
6	112	14	184	22	54	30	114	38 1328
7	251	15	191	23	37	31	729	
8	510	16	106	24	59	32	187	

Surface Heights mm

0 -595 620 685 735 680 620 -595 0

TEST 31			SET 5			microvolts		
1	0	9	184	17	232	25	-3776	33 141
2	-11	10	241	18	36	26	105	34 50
3	19	11	228	19	433	27	194	35 68
4	45	12	233	20	-8	28	127	36 105
5	22	13	-722	21	48	29	184	37 638
6	119	14	188	22	59	30	116	38 1325
7	262	15	176	23	45	31	727	
8	512	16	102	24	68	32	165	

Surface Heights mm

0 -595 620 675 725 675 620 -595 0

TEST 31			SET 6			microvolts		
1	0	9	185	17	230	25	-3767	33 109
2	-13	10	241	18	34	26	105	34 40
3	16	11	221	19	416	27	197	35 58
4	45	12	230	20	-9	28	130	36 104
5	22	13	-710	21	48	29	183	37 618
6	124	14	125	22	63	30	121	38 1318
7	267	15	167	23	48	31	722	
8	514	16	78	24	77	32	137	

Surface Heights mm

0 -590 615 670 720 670 615 -590 0

D1-17

TEST 31			SET 7			microvolts		
1	0	9	182	17	220	25	-3763	33 81
2	-14	10	234	18	35	26	105	34 41
3	19	11	212	19	403	27	199	35 57
4	48	12	224	20	-10	28	131	36 102
5	27	13	-712	21	48	29	173	37 596
6	130	14	90	22	63	30	97	38 1310
7	274	15	150	23	52	31	731	
8	514	16	72	24	77	32	114	

Surface Heights mm

0 -590 610 665 715 665 615 -590 0

TEST 31			SET 8			microvolts		
1	0	9	184	17	223	25	-3759	33 102
2	-14	10	240	18	34	26	109	34 41
3	19	11	217	19	398	27	195	35 62
4	51	12	233	20	-10	28	125	36 104
5	28	13	-713	21	47	29	179	37 586
6	131	14	97	22	63	30	88	38 1302
7	277	15	151	23	54	31	733	
8	511	16	87	24	83	32	118	

Surface Heights mm

0 -590 610 665 710 665 615 -590 0

TEST 31			SET 9			microvolts		
1	0	9	184	17	227	25	-3760	33 91
2	-14	10	238	18	35	26	108	34 40
3	20	11	196	19	397	27	197	35 60
4	52	12	199	20	-11	28	130	36 105
5	30	13	-724	21	47	29	183	37 580
6	131	14	115	22	67	30	100	38 1297
7	279	15	145	23	56	31	727	
8	509	16	96	24	84	32	117	

Surface Heights mm

0 -590 610 660 705 660 615 -590 0

D1-18

TEST 31			SET 10			microvolts		
1	0	9	182	17	219	25	-3765	33 102
2	-13	10	218	18	33	26	114	34 39
3	17	11	191	19	389	27	285	35 59
4	50	12	212	20	-10	28	133	36 100
5	24	13	-732	21	42	29	176	37 574
6	127	14	133	22	63	30	87	38 1282
7	280	15	144	23	54	31	719	
8	508	16	81	24	84	32	138	

Surface Heights mm

0 -585 610 655 700 650 615 -590 0

TEST 31			SET 11			microvolts		
1	0	9	181	17	226	25	-3777	33 100
2	-13	10	212	18	34	26	110	34 41
3	7	11	182	19	388	27	190	35 59
4	43	12	235	20	-10	28	124	36 102
5	19	13	-739	21	36	29	175	37 573
6	129	14	117	22	61	30	95	38 1264
7	275	15	126	23	48	31	710	
8	512	16	79	24	72	32	106	

Surface Heights mm

0 -585 605 645 690 645 615 -593 0

TEST 31			SET 12			microvolts		
1	0	9	155	17	231	25	-3831	33 67
2	-11	10	227	18	36	26	91	34 56
3	0	11	177	19	368	27	188	35 68
4	9	12	201	20	-11	28	120	36 102
5	-3	13	-791	21	30	29	167	37 567
6	101	14	103	22	25	30	88	38 1186
7	236	15	133	23	27	31	674	
8	481	16	84	24	51	32	148	

Surface Heights mm

0 -585 605 600 645 600 605 -590 0

TEST 31				SET 13		microvolts			
1	0	9	137	17	225	25	-3878	33	92
2	-10	10	199	18	36	26	72	34	61
3	-1	11	132	19	380	27	167	35	63
4	-6	12	197	20	-11	28	120	36	102
5	-30	13	-841	21	28	29	174	37	538
6	82	14	106	22	16	30	109	38	1068
7	178	15	153	23	-1	31	635		
8	455	16	86	24	23	32	124		

Surface Heights mm

0 -580 575 560 570 555 580 -580 0

APPENDIX D2

STRESSES - BIN 2

D2-1

TEST 27 SET 2

Weight= 1474.7 N		Volume= 93.5 Litres	
Density= 1607.2 Kg/M ³		Weight Factor= 1.204	
Normal Stress(Pa)		Shear Stress/Friction Angle	
189.2	94.5	518.9 Pa	400.5 Pa
487.6	520.3	30.56 Deg	24.82 Deg
835.3	1252.6		
1277.4	1225.9		
1596.1	1323.1		
3699.0	3336.0	1642.6 Pa	1520.2 Pa
4223.9	4413.6	21.22 Deg	19.81 Deg
4277.2	4366.6		
4117.0	4251.7		
4818.6	4822.5		
4931.1	5130.1	1776.8 Pa	2173.3 Pa
5309.7	5377.4	18.38 Deg	24.30 Deg
5815.2	4713.7		
5884.8	4948.7		
5031.0	4038.5		

TEST 27 SET 3

Weight= 1467.0 N		Volume= 93.5 Litres	
Density= 1598.8 Kg/M ³		Weight Factor= 1.148	
Normal Stress(Pa)		Shear Stress/Friction Angle	
90.2	22.5	590.4 Pa	473.1 Pa
492.2	522.1	28.94 Deg	24.15 Deg
1035.1	1364.2		
1645.7	1625.1		
2068.4	1824.4		
4711.8	4264.4	2015.7 Pa	1921.6 Pa
5526.2	5702.7	19.74 Deg	19.75 Deg
5806.6	5774.1		
5606.8	5470.4		
6455.2	5755.5		
5601.6	5278.7	1434.1 Pa	1691.4 Pa
4936.3	5743.9	21.15 Deg	25.38 Deg
3764.5	3356.6		
2977.8	2406.3		
1385.5	1233.2		

TEST 27 SET 4

Weight= 1462.6 N Volume= 92.6 Litres
 Density= 1610.6 Kg/M³ Weight Factor= 1.164

Normal Stress(Pa)		Shear Stress/Friction Angle	
51.0	0.0	537.4 Pa	513.3 Pa
693.1	502.9	27.97 Deg	23.81 Deg
1170.5	1491.5		
1801.9	1851.1		
2289.9	2055.2		
4900.4	4396.7	2104.2 Pa	2007.3 Pa
5940.6	5922.7	19.93 Deg	19.97 Deg
6096.3	6080.9		
5813.6	5689.8		
6373.0	5799.6		
5137.0	5089.4	1359.1 Pa	1583.4 Pa
4644.1	5604.3	22.24 Deg	25.43 Deg
3254.5	2662.1		
2426.0	2182.8		
1242.6	1219.8		

TEST 27 SET 5

Weight= 1446.0 N Volume= 91.4 Litres
 Density= 1612.2 Kg/M³ Weight Factor= 1.179

Normal Stress(Pa)		Shear Stress/Friction Angle	
30.9	0.0	688.1 Pa	553.9 Pa
645.7	589.6	27.84 Deg	23.39 Deg
1348.8	1620.2		
1993.6	2079.5		
2514.1	2219.9		
5305.6	4600.7	2183.4 Pa	2080.6 Pa
6158.2	6426.0	20.49 Deg	19.95 Deg
6093.8	6387.6		
5599.3	5878.1		
6130.9	5726.7		
3843.6	4888.1	1283.3 Pa	1464.4 Pa
3758.0	4089.9	24.11 Deg	25.55 Deg
3325.6	2668.0		
2238.3	2437.9		
1340.4	1235.2		

TEST 27 SET 6

Weight= 1392.0 N Volume= 87.4 Litres
 Density= 1623.4 Kg/M³ Weight Factor= 1.192

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	0.0	699.1 Pa	565.8 Pa
425.8	325.2	27.86 Deg	23.77 Deg
1302.0	1638.4		
2084.3	2162.0		
2764.4	2361.7		
5365.1	5065.0	2107.4 Pa	2022.2 Pa
6140.8	6281.4	20.29 Deg	19.60 Deg
6162.1	5529.8		
5238.7	5355.5		
5697.6	6193.7		
2951.5	3814.6	1216.2 Pa	1379.1 Pa
3800.1	4296.0	25.32 Deg	26.17 Deg
2787.2	2641.7		
2291.0	2202.3		
1300.1	1249.0		

TEST 27 SET 7

Weight= 1215.5 N Volume= 76.4 Litres
 Density= 1621.6 Kg/M³ Weight Factor= 1.172

Normal Stress(Pa)		Shear Stress/Friction Angle	
30.7	0.0	429.9 Pa	313.4 Pa
83.7	53.3	34.71 Deg	30.66 Deg
365.7	382.2		
772.6	727.9		
1698.5	1379.2		
3940.0	3171.8	1818.9 Pa	1758.7 Pa
4818.0	5074.7	20.03 Deg	21.26 Deg
5846.9	5984.2		
5748.1	5409.3		
4934.8	3653.2		
4194.2	4383.7	1164.7 Pa	1302.7 Pa
3244.7	3844.9	23.22 Deg	24.72 Deg
2799.5	2707.4		
2118.5	2003.4		
1223.7	1227.8		

TEST 27 SET 8

Weight= 1036.8 N Volume= 65.2 Litres
 Density= 1620.6 Kg/M³ Weight Factor= 1.151

Normal Stress(Pa)		Shear Stress/Friction Angle	
60.3	0.0	214.3 Pa	166.4 Pa
-27.4	-52.3	47.44 Deg	39.50 Deg
139.7	160.9		
164.9	265.9		
571.9	564.4		
2650.7	2426.8	1569.4 Pa	1522.6 Pa
4063.6	3973.1	21.41 Deg	22.31 Deg
4112.6	4486.1		
4470.0	3920.3		
4870.5	4045.0		
3131.6	3682.7	1095.4 Pa	1204.3 Pa
3438.1	4333.1	23.45 Deg	24.03 Deg
2895.6	2387.5		
2185.1	2094.4		
1201.7	1175.7		

TEST 27 SET 9

Weight= 803.0 N Volume= 48.9 Litres
 Density= 1673.3 Kg/M³ Weight Factor= 1.120

Normal Stress(Pa)		Shear Stress/Friction Angle	
58.7	0.0	118.3 Pa	72.9 Pa
26.7	-25.5	74.95 Deg	67.16 Deg
19.4	26.1		
-96.3	27.8		
116.0	109.9		
593.1	564.1	1099.8 Pa	1132.1 Pa
1164.9	983.7	25.70 Deg	25.50 Deg
1938.5	2401.6		
3381.2	3566.9		
4491.2	4313.7		
3789.5	3660.2	1027.9 Pa	1107.5 Pa
3183.2	3765.7	21.63 Deg	23.12 Deg
2789.9	2640.8		
2100.9	1915.0		
1169.7	1115.0		

TEST 27 SET 10

Weight= 632.0 N
Density= 1693.2 Kg/M³

Volume= 38.0 Litres
Weight Factor= 1.124

Normal Stress(Pa)		Shear Stress/Friction Angle	
29.4	0.0	96.9 Pa	54.2 Pa
0.0	0.0	89.50 Deg	74.75 Deg
0.0	26.2		
-64.4	27.9		
23.3	22.1		
-29.8	212.3	688.4 Pa	759.3 Pa
679.7	510.6	25.60 Deg	28.62 Deg
1010.6	876.4		
1521.9	1109.9		
3739.6	3847.9		
2948.6	3166.5	990.2 Pa	1040.9 Pa
3214.8	3809.2	22.56 Deg	22.56 Deg
2628.3	2385.0		
2186.4	2200.7		
1147.7	1177.8		

TEST 28 SET 2

Weight= 1478.0 N Volume= 94.2 Litres
 Density= 1599.1 Kg/M³ Weight Factor= 1.205

Normal Stress(Pa)		Shear Stress/Friction Angle	
157.9	94.6	412.2 Pa	398.0 Pa
689.2	575.7	24.78 Deg	24.76 Deg
815.2	1095.4		
1278.8	1258.2		
1547.9	1371.8		
3894.4	3187.7	1680.2 Pa	1573.8 Pa
4374.1	4199.2	20.74 Deg	21.35 Deg
4417.2	4700.2		
4496.0	4047.8		
5001.4	4201.1		
5025.0	5026.8	1756.4 Pa	2208.8 Pa
5447.1	5350.6	18.05 Deg	24.41 Deg
5546.5	4718.6		
5863.0	4987.1		
5232.2	4358.6		

TEST 28 SET 3

Weight= 1469.2 N Volume= 94.2 Litres
 Density= 1589.6 Kg/M³ Weight Factor= 1.179

Normal Stress(Pa)		Shear Stress/Friction Angle	
92.6	23.1	494.7 Pa	465.8 Pa
561.5	616.4	24.59 Deg	23.17 Deg
1021.8	1318.1		
1621.3	1698.7		
2099.1	1873.0		
5180.6	4303.8	2142.5 Pa	2077.5 Pa
5673.4	5462.0	20.03 Deg	21.95 Deg
5828.8	5881.9		
6017.8	5983.3		
6652.0	5044.1		
5461.9	5233.3	1416.5 Pa	1689.1 Pa
4745.7	5167.7	21.58 Deg	26.24 Deg
3655.1	3195.9		
2784.2	2340.4		
1367.7	1296.9		

TEST 28 SET 4

Weight= 1464.8 N Volume= 93.1 Litres
 Density= 1603.6 Kg/M³ Weight Factor= 1.190

Normal Stress(Pa)		Shear Stress/Friction Angle	
31.2	0.0	539.4 Pa	507.8 Pa
595.4	595.5	24.51 Deg	23.61 Deg
1135.2	1469.9		
1842.8	1863.5		
2317.3	1985.1		
5358.4	1421.7	2217.0 Pa	2119.4 Pa
5787.6	5732.8	20.22 Deg	21.83 Deg
5993.9	6126.3		
6130.7	5319.5		
6793.5	5167.2		
5020.1	5070.9	1361.8 Pa	1589.5 Pa
4511.1	5187.2	22.55 Deg	26.11 Deg
3237.6	2666.5		
2481.1	2133.9		
1243.2	1216.3		

TEST 28 SET 5

Weight= 1453.8 N Volume= 91.8 Litres
 Density= 1613.8 Kg/M³ Weight Factor= 1.175

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	23.1	588.2 Pa	524.1 Pa
728.0	668.2	23.50 Deg	22.74 Deg
1304.4	1561.1		
2156.8	1927.7		
2604.7	2167.8		
5695.9	4773.3	2165.9 Pa	2170.5 Pa
6056.3	6088.2	19.84 Deg	21.37 Deg
6183.1	6416.2		
5923.4	5775.2		
6188.6	5066.5		
3545.0	5272.3	1273.6 Pa	1469.3 Pa
4433.2	4964.2	23.10 Deg	24.10 Deg
3525.8	2650.8		
2504.5	2236.9		
1282.2	1293.4		

TEST 28 SET 6

Weight= 1426.2 N Volume= 90.5 Litres
 Density= 1606.6 Kg/M³ Weight Factor= 1.150

Normal Stress(Pa)		Shear Stress/Friction Angle	
-93.5	0.0	641.8 Pa	550.7 Pa
708.7	595.4	24.16 Deg	22.57 Deg
1485.7	1691.4		
2320.0	2099.6		
2785.0	2334.8		
5514.6	4907.6	2166.2 Pa	2155.2 Pa
6333.1	6272.0	19.81 Deg	20.80 Deg
6233.2	6495.9		
5759.3	5729.5		
6290.6	5311.4		
3647.5	3513.9	1220.6 Pa	1374.0 Pa
4293.1	4897.8	23.61 Deg	25.73 Deg
2541.1	2497.4		
2452.9	2395.9		
1242.9	1247.2		

TEST 28 SET 7

Weight= 1401.9 N Volume= 87.7 Litres
 Density= 1628.6 Kg/M³ Weight Factor= 1.189

Normal Stress(Pa)		Shear Stress/Friction Angle	
-62.3	0.0	631.1 Pa	538.5 Pa
424.7	405.4	24.55 Deg	22.57 Deg
1401.5	1634.0		
2249.1	2156.2		
2880.1	2355.4		
6011.7	4864.3	2140.1 Pa	2119.4 Pa
5923.1	6408.6	20.04 Deg	20.79 Deg
5878.5	6395.5		
5778.8	5781.4		
5732.4	4905.4		
4400.9	3831.2	1212.9 Pa	1348.5 Pa
2967.0	4188.6	23.31 Deg	26.24 Deg
3112.1	2578.6		
2312.4	1999.7		
1269.0	1214.5		

TEST 28 SET 8

Weight= 1238.7 N Volume= 77.2 Litres
Density= 1635.4 Kg/M³ Weight Factor= 1.181

Normal Stress(Pa)		Shear Stress/Friction Angle	
-61.8	0.0	374.2 Pa	281.7 Pa
56.3	107.4	30.39 Deg	25.38 Deg
389.0	495.2		
914.0	792.2		
1750.6	1482.6		
4252.2	3568.3	1935.6 Pa	1910.4 Pa
4998.3	5114.3	21.98 Deg	21.29 Deg
5228.9	5386.3		
5425.9	5101.7		
4376.5	5558.6		
3445.2	4577.6	1192.4 Pa	1304.0 Pa
3721.7	4160.8	24.67 Deg	23.97 Deg
2341.1	2672.8		
2433.8	2116.7		
1205.8	1175.5		

TEST 28 SET 9

Weight= 1085.4 N Volume= 67.2 Litres
Density= 1646.5 Kg/M³ Weight Factor= 1.133

Normal Stress(Pa)		Shear Stress/Friction Angle	
-29.7	0.0	148.1 Pa	142.0 Pa
-54.0	0.0	34.49 Deg	31.54 Deg
157.2	264.0		
162.4	366.1		
750.9	511.3		
2970.5	2746.7	1666.4 Pa	1612.2 Pa
4413.1	4290.3	21.61 Deg	21.40 Deg
4406.8	5036.6		
4150.7	4112.6		
5178.4	5299.9		
3889.8	3780.0	1111.6 Pa	1208.8 Pa
3262.0	3627.3	22.86 Deg	24.71 Deg
2678.8	2565.0		
2230.7	2062.6		
1183.5	1187.5		

TEST 28 SET 10

Weight= 799.7 N Volume= 48.7 Litres
 Density= 1673.2 Kg/M³ Weight Factor= 1.149

Normal Stress (Pa)		Shear Stress/Friction Angle	
-30.1	0.0	0.0 Pa	38.8 Pa
0.0	-26.1	0.00 Deg	31.54 Deg
-19.9	0.0		
-98.8	0.0		
47.6	112		
547.7	651.1	1119.9 Pa	1150.0 Pa
1111.9	1218.2	21.61 Deg	21.40 Deg
2221.5	2464.2		
3520.4	3376.2		
4501.2	4707.1		
3352.9	3211.7	1054.7 Pa	1150.8 Pa
3370.8	4296.6	22.86 Deg	24.71 Deg
2541.3	2248.9		
2235.5	2028.3		
1120.2	1174.1		

TEST 28 SET 11

Weight= 621.0 N Volume= 37.4 Litres
 Density= 1693.5 Kg/M³ Weight Factor= 1.145

Normal Stress (Pa)		Shear Stress/Friction Angle	
0.0	0.0	-19.1 Pa	13.8 Pa
0.0	-26.0	32.40 Deg	-70.77 Deg
-39.7	0.0		
-98.5	28.5		
-23.7	-22.5		
60.6	108.1	692.9 Pa	741.7 Pa
637.1	624.3	29.01 Deg	28.27 Deg
978.2	848.3		
1220.2	1272.3		
3135.0	3710.6		
3200.9	3871.6	1002.9 Pa	1077.8 Pa
3275.6	3449.9	21.67 Deg	22.76 Deg
2736.2	2403.1		
2413.3	2021.2		
1196.0	1140.1		

TEST 29 SET 2

Weight= 1435.0 N Volume= 93.0 Litres
 Density= 1572.7 Kg/M³ Weight Factor= 1.173

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	0.0	414.3 Pa	350.7 Pa
670.8	480.3	26.56 Deg	22.88 Deg
732.5	1066.3		
1345.7	1253.9		
458.1	1427.5		
5759.9	3324.7	1603.5 Pa	1439.6 Pa
4059.2	4371.9	20.96 Deg	19.16 Deg
3904.2	4117.8		
3350.5	4143.1		
4794.4	4807.0		
4675.0	5369.3	1666.6 Pa	2138.4 Pa
5233.8	5397.8	17.72 Deg	23.34 Deg
5657.8	4953.0		
5788.8	5145.9		
5611.5	4058.3		

TEST 29 SET 3

Weight= 1328.4 N Volume= 91.9 Litres
 Density= 1584.6 Kg/M³ Weight Factor= 1.127

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	22.1	479.4 Pa	396.6 Pa
671.3	332.2	25.80 Deg	23.71 Deg
938.2	1050.6		
1518.9	1344.5		
1867.6	1759.3		
4805.6	4122.7	1942.9 Pa	1818.1 Pa
5371.7	5545.4	19.33 Deg	18.83 Deg
5169.3	5161.9		
5855.7	5871.4		
6433.3	6292.6		
5638.4	5538.8	1393.3 Pa	1669.3 Pa
5093.4	5397.3	20.47 Deg	25.05 Deg
3667.7	3508.8		
3080.5	2362.7		
1334.3	1181.3		

TEST 29 SET 4

Weight= 1421.8 N		Volume= 91.5 Litres	
Density= 1584.2 Kg/M ³		Weight Factor= 1.137	
Normal Stress(Pa)		Shear Stress/Friction Angle	
-29.8	22.3	521.7 Pa	444.0 Pa
568.9	413.8	26.58 Deg	22.64 Deg
1045.2	1298.4		
1630.3	1639.2		
2025.6	1985.9		
4930.9	4582.6	2053.3 Pa	1892.1 Pa
5777.2	5718.4	19.55 Deg	19.08 Deg
5573.4	5808.8		
6135.1	5553.7		
6514.7	5840.8		
5382.0	5331.9	1325.0 Pa	1547.2 Pa
4247.8	5537.3	21.79 Deg	25.19 Deg
3498.1	2413.5		
2344.2	2070.2		
1135.0	1132.3		

TEST 29 SET 5

Weight= 1416.3 N		Volume= 91.3 Litres	
Density= 1581.5 Kg/M ³		Weight Factor= 1.138	
Normal Stress(Pa)		Shear Stress/Friction Angle	
-59.6	0.0	544.2 Pa	460.8 Pa
569.3	388.2	26.51 Deg	22.90 Deg
1164.4	1293.4		
1696.8	1753.6		
2121.4	2054.4		
5093.4	4514.5	2071.8 Pa	1928.2 Pa
5809.2	5653.9	19.86 Deg	19.15 Deg
5705.6	6079.6		
5887.2	5676.4		
6232.1	6019.3		
5162.9	4925.6	1284.1 Pa	1471.2 Pa
4513.3	5602.8	21.74 Deg	24.34 Deg
3637.9	2415.4		
2425.1	2322.9		
1188.7	1133.1		

TEST 29 SET 6

Weight= 1410.7 N Volume= 90.1 Litres
 Density= 1595.7 Kg/M³ Weight Factor= 1.139

Normal Stress(Pa)		Shear Stress/Friction Angle	
-29.8	0.0	573.3 Pa	488.8 Pa
651.3	492.3	25.70 Deg	21.69 Deg
1284.2	1460.1		
1861.9	1925.3		
2241.6	2257.7		
5038.4	4662.6	2090.9 Pa	1921.6 Pa
5842.9	5935.8	19.54 Deg	18.81 Deg
5916.5	6085.9		
6146.3	5541.7		
6574.5	6130.0		
4330.2	4725.3	1246.5 Pa	1387.0 Pa
4670.7	4505.3	21.80 Deg	24.35 Deg
3070.0	3062.7		
2612.3	1979.7		
1137.1	1134.3		

TEST 29 SET 7

Weight= 1405.2 N Volume= 89.9 Litres
 Density= 1592.0 Kg/M³ Weight Factor= 1.158

Normal Stress(Pa)		Shear Stress/Friction Angle	
-60.7	-22.7	592.4 Pa	502.4 Pa
662.1	500.4	25.44 Deg	22.29 Deg
1345.6	1484.2		
1992.3	1928.3		
2350.6	2295.1		
5305.7	4812.7	2131.2 Pa	1971.0 Pa
6135.6	6174.3	19.76 Deg	19.20 Deg
6118.5	6276.9		
6119.4	5719.1		
6122.2	5594.1		
3549.8	4751.2	1221.5 Pa	1389.6 Pa
4262.6	4299.4	23.42 Deg	24.86 Deg
3032.4	2512.5		
2387.3	2267.9		
1155.9	1183.4		

TEST 30 SET 2

Weight= 1465.9 N Volume= 94.3 Litres
 Density= 1584.6 Kg/M³ Weight Factor= 1.226

Normal Stress(Pa)		Shear Stress/Friction Angle	
192.6	72.2	446.5 Pa	390.0 Pa
496.4	529.7	27.69 Deg	24.48 Deg
744.0	1142.5		
1159.8	1188.1		
1624.9	1419.1		
4025.3	3280.3	1705.6 Pa	1525.8 Pa
4092.4	4418.8	21.52 Deg	20.61 Deg
3996.0	4206.2		
4381.6	4086.1		
5008.6	4422.2		
4839.5	5001.4	1792.6 Pa	2175.5 Pa
5182.0	5210.4	18.72 Deg	24.56 Deg
5546.9	4769.6		
5621.6	4834.9		
5377.7	4111.2		

TEST 30 SET 3

Weight= 1461.5 N Volume= 94.3 Litres
 Density= 1579.8 Kg/M³ Weight Factor= 1.268

Normal Stress(Pa)		Shear Stress/Friction Angle	
158.2	47.4	537.3 Pa	462.8 Pa
575.4	466.9	27.47 Deg	25.66 Deg
984.4	1210.2		
1419.8	1470.8		
2001.2	1682.6		
5117.5	4372.7	2114.8 Pa	1942.0 Pa
5288.5	5670.9	20.81 Deg	20.54 Deg
5430.6	5227.5		
5684.7	5248.7		
6232.2	5536.7		
5123.7	5009.5	1502.6 Pa	1779.6 Pa
4819.6	5588.6	22.79 Deg	27.35 Deg
3715.2	3104.5		
3021.2	2465.2		
1401.7	1234.2		

TEST 30 SET 4

Weight= 1453.8 N Volume= 92.4 Litres
 Density= 1604.3 Kg/M³ Weight Factor= 1.201

Normal Stress(Pa)		Shear Stress/Friction Angle	
157.3	23.6	574.3 Pa	492.1 Pa
629.4	518.9	25.62 Deg	24.20 Deg
1207.9	1371.2		
1721.7	1671.4		
2263.5	1955.8		
5247.5	4499.2	2195.2 Pa	2022.6 Pa
5578.2	5820.7	20.93 Deg	21.07 Deg
5615.8	5619.4		
5865.8	5337.6		
6348.7	5213.6		
5359.8	5008.2	1396.7 Pa	1603.8 Pa
4420.3	5427.7	22.20 Deg	25.90 Deg
3663.6	2888.7		
2308.7	2120.0		
1282.3	1195.7		

TEST 30 SET 5

Weight= 1448.2 N Volume= 92.0 Litres
 Density= 1605.2 Kg/M³ Weight Factor= 1.204

Normal Stress(Pa)		Shear Stress/Friction Angle	
63.1	23.6	609.1 Pa	513.6 Pa
659.6	547.5	25.55 Deg	23.19 Deg
1252.5	1514.8		
1932.9	1765.1		
2468.4	2196.7		
5578.9	4699.5	2221.4 Pa	2045.8 Pa
5591.5	6017.0	21.00 Deg	20.41 Deg
5872.9	6008.4		
5906.6	5528.8		
5983.6	5483.7		
3985.2	5237.3	1320.3 Pa	1529.0 Pa
4738.0	4728.2	23.15 Deg	25.26 Deg
2968.5	2924.0		
2676.7	2125.0		
1341.3	1198.6		

TEST 30 SET 6

Weight= 1439.4 N Volume= 91.4 Litres
 Density= 1605.9 Kg/M³ Weight Factor= 1.207

Normal Stress(Pa)		Shear Stress/Friction Angle	
63.2	23.7	640.8 Pa	538.1 Pa
718.7	548.9	25.76 Deg	23.05 Deg
1318.4	1659.1		
1937.7	1889.4		
2599.5	2273.2		
5784.5	4749.1	2241.8 Pa	2072.3 Pa
5663.8	6397.4	20.66 Deg	20.15 Deg
6077.3	6352.7		
5974.8	5661.6		
6201.8	5423.5		
3225.6	4679.0	1272.8 Pa	1435.9 Pa
4419.9	4447.8	24.34 Deg	25.15 Deg
3190.6	2589.7		
2403.8	2363.3		
1204.5	1264.8		

TEST 30 SET 7

Weight= 1425.1 N Volume= 90.2 Litres
 Density= 1610.4 Kg/M³ Weight Factor= 1.216

Normal Stress(Pa)		Shear Stress/Friction Angle	
0.0	0.0	665.9 Pa	548.0 Pa
695.1	608.3	24.58 Deg	22.29 Deg
1496.9	1756.4		
2196.1	2024.4		
2895.8	2385.5		
5755.3	4669.6	2264.5 Pa	2078.4 Pa
5676.5	6408.2	21.00 Deg	20.04 Deg
6204.5	6447.3		
6073.3	5793.8		
5812.6	5538.2		
3756.5	3014.6	1243.9 Pa	1361.1 Pa
3921.1	5069.6	23.58 Deg	26.27 Deg
3028.9	2695.0		
2449.9	2246.8		
1298.1	1178.7		

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TEST 30 SET 8

Weight= 1415.1 N Volume= 89.0 Litres
 Density= 1620.5 Kg/M³ Weight Factor= 1.208

Normal Stress(Pa)		Shear Stress/Friction Angle	
-63.3	-23.7	658.3 Pa	547.4 Pa
633.1	549.4	24.80 Deg	22.37 Deg
1508.3	1717.0		
2147.4	2071.4		
2902.2	2417.7		
5726.2	4791.8	2244.0 Pa	2071.2 Pa
5640.1	6367.1	20.71 Deg	20.30 Deg
6354.9	6311.8		
6329.4	5846.2		
5749.9	5056		
4117.5	3948	1213.7 Pa	1328.1 Pa
3213.6	4192.1	23.37 Deg	25.26 Deg
2978.8	2848.6		
2546.1	2032.4		
1261.8	1202.8		

TEST 31 SET 2

Weight= 1452.7 N Volume= 93.8 Litres
 Density= 1578.4 Kg/M³ Weight Factor= 1.185

Normal Stress(Pa)		Shear Stress/Friction Angle	
-372.4	-46.5	399.5 Pa	399.7 Pa
366.9	377.2	33.27 Deg	26.78 Deg
719.0	1104.2		
951.1	1295.4		
1423.1	1325.0		
3921.6	2946.5	1660.1 Pa	1489.6 Pa
4127.0	4414.1	21.25 Deg	20.16 Deg
3941.8	4573.3		
4445.1	4212.3		
4840.6	4382.5		
4680.6	4780.2	1741.8 Pa	2135.2 Pa
5418.3	5258.7	17.79 Deg	24.17 Deg
5993.3	4861.1		
5652.6	5032.2		
5389.8	4066.4		

TEST 31 SET 3

Weight= 1441.6 N Volume= 93.8 Litres
 Density= 1566.4 Kg/M³ Weight Factor= 1.154

Normal Stress(Pa)		Shear Stress/Friction Angle	
-151.1	22.6	490.8 Pa	467.2 Pa
412.3	419.8	28.03 Deg	26.14 Deg
980.4	1156.1		
1356.4	1519.8		
2007.4	1698.0		
4552.9	3741.6	2080.5 Pa	1937.4 Pa
5471.1	5592.4	20.38 Deg	20.78 Deg
5525.3	5803.9		
6045.7	5327.7		
6464.3	5397.2		
5432.5	4967.8	1426.4 Pa	1711.8 Pa
5130.0	5308.0	21.49 Deg	26.74 Deg
3871.9	3401.2		
2592.3	2291.4		
1258.8	1209.3		

TEST 31 SET 4

Weight= 1435.0 N		Volume= 92.7 Litres	
Density= 1578.8 Kg/M ³		Weight Factor= 1.165	
Normal Stress(Pa)		Shear Stress/Friction Angle	
-183.0	0.0	531.0 Pa	499.7 Pa
471.7	397.3	27.84 Deg	25.95 Deg
1131.0	1329.8		
1569.5	1678.8		
2074.5	1805.4		
4719.0	3996.7	2152.0 Pa	2023.6 Pa
5607.0	5962.5	20.62 Deg	21.13 Deg
5708.1	6040.1		
6102.5	5291.5		
6525.0	5269.9		
5397.9	4988.3	1350.9 Pa	1608.0 Pa
4562.8	4981.8	22.24 Deg	26.61 Deg
3227.3	2664.1		
2185.1	2216.6		
1162.5	1251.2		

TEST 31 SET 5

Weight= 1431.7 N		Volume= 91.7 Litres	
Density= 1592.3 Kg/M ³		Weight Factor= 1.167	
Normal Stress(Pa)		Shear Stress/Friction Angle	
-152.8	0.0	567.7 Pa	528.7 Pa
528.1	477.6	26.86 Deg	24.57 Deg
1254.4	1468.1		
1773.0	1913.7		
2247.4	2014.6		
4789.2	4114.0	2161.6 Pa	2021.3 Pa
5871.0	6114.4	20.72 Deg	20.64 Deg
5980.6	6141.8		
6165.1	5502.6		
5971.4	5350.5		
5521.9	4418.5	1307.3 Pa	1540.5 Pa
4252.0	5336.0	21.98 Deg	26.22 Deg
3114.4	2503.8		
2107.9	2349.2		
1137.5	1222.8		

TEST 31 SET 6

Weight= 1424.0 N		Volume= 90.7 Litres	
Density= 1600.6 Kg/M ³		Weight Factor= 1.202	
Normal Stress(Pa)		Shear Stress/Friction Angle	
-220.3	-23.6	601.4 Pa	570.6 Pa
458.0	491.9	27.54 Deg	24.18 Deg
1292.0	1624.1		
1826.1	2060.6		
2499.1	2287.2		
4996.2	4237.2	2262.1 Pa	2066.6 Pa
6075.9	6406.8	21.13 Deg	20.23 Deg
6159.7	6466.3		
6163.0	5637.7		
6074.3	5694.5		
3830.8	3792.3	1292.7 Pa	1526.3 Pa
4182.2	4461.3	25.47 Deg	29.09 Deg
2474.5	2295.4		
2115.3	2088.1		
1115.7	1228.0		

TEST 31 SET 7

Weight= 1415.1 N		Volume= 89.9 Litres	
Density= 1603.8 Kg/M ³		Weight Factor= 1.239	
Normal Stress(Pa)		Shear Stress/Friction Angle	
-259.7	-48.6	644.3 Pa	600.3 Pa
560.9	507.3	26.78 Deg	24.35 Deg
1396.8	1674.8		
2060.8	2248.1		
2669.2	2358.5		
5152.1	4369.4	2326.6 Pa	2159.4 Pa
6175.5	6681.7	21.50 Deg	21.30 Deg
6156.8	6716.4		
6107.7	5507.6		
6107.2	4962.9		
2886.8	3268.2	1290.7 Pa	1505.5 Pa
3928.9	3667.0	28.23 Deg	31.08 Deg
2362.7	2396.2		
1894.3	2119.1		
1179.3	1201.4		

TEST 31 SET 8

Weight= 1406.3 N Volume= 89.7 Litres
 Density= 1597.4 Kg/M³ Weight Factor= 1.219

Normal Stress(Pa)		Shear Stress/Friction Angle	
-255.4	-47.8	644.0 Pa	602.4 Pa
551.8	471.3	26.72 Deg	24.13 Deg
1437.6	1647.6		
2062.3	2272.3		
2651.2	2463.9		
4971.9	4452.2	2285.9 Pa	2130.6 Pa
6134.5	6425.8	21.16 Deg	21.67 Deg
6221.6	6822.4		
6144.1	5699.0		
6239.4	4547.1		
3049.3	3325.2	1253.8 Pa	1450.5 Pa
3887.5	4296.4	26.55 Deg	28.70 Deg
2789.3	2357.4		
1948.4	2252.9		
1131.9	1245.8		

TEST 31 SET 9

Weight= 1400.8 N Volume= 89.1 Litres
 Density= 1601.8 Kg/M³ Weight Factor= 1.220

Normal Stress(Pa)		Shear Stress/Friction Angle	
-255.5	-71.8	651.0 Pa	599.6 Pa
581.0	471.5	26.58 Deg	23.55 Deg
1459.2	1761.9		
2133.0	2333.7		
2652.1	2488.6		
4908.9	4415.3	2253.4 Pa	2112.7 Pa
6136.7	6501.8	22.00 Deg	20.89 Deg
6168.8	6562.3		
5577.6	5721.3		
5368.2	4996.0		
3588.6	3298.8	1251.0 Pa	1432.7 Pa
3755.4	3936.9	24.96 Deg	28.70 Deg
3069.3	2588.3		
2062.0	2186.4		
1150.6	1278.2		

TEST 31 SET 10

Weight= 1384.3 N Volume= 88.3 Litres
 Density= 1598.0 Kg/M³ Weight Factor= 1.212

Normal Stress(Pa)		Shear Stress/Friction Angle	
-222.2	-47.6	650.3 Pa	581.3 Pa
490.8	330.7	28.12 Deg	23.81 Deg
1408.1	1637.9		
1911.1	2258.9		
2535.1	2473.1		
4846.1	4616.6	2215.2 Pa	2074.9 Pa
6039.5	6754.9	22.01 Deg	20.73 Deg
5585.4	6663.1		
5408.2	5476.1		
5665.5	4483.1		
4101.1	3851.9	1217.6 Pa	1405.5 Pa
3709.9	4271.0	24.62 Deg	27.46 Deg
2587.9	2286.3		
1824.5	2139.3		
1097.1	1111.4		

TEST 31 SET 11

Weight= 1364.4 N Volume= 87.2 Litres
 Density= 1595.7 Kg/M³ Weight Factor= 1.218

Normal Stress(Pa)		Shear Stress/Friction Angle	
-223.3	-47.8	636.7 Pa	549.0 Pa
203.1	166.2	29.48 Deg	24.85 Deg
1267.4	1589.5		
1746.3	2088.8		
2598.6	2199.0		
5000.1	4486.9	2205.5 Pa	2057.7 Pa
6041.1	6236.1	21.50 Deg	20.99 Deg
5449.8	6269.8		
5192.6	5474.2		
6285.7	4804.1		
3644.3	2993.0	1220.7 Pa	1409.6 Pa
3329.4	4227.4	25.86 Deg	29.16 Deg
2539.3	2355.5		
2031.4	2150.3		
1131.0	1181.0		

TEST 31 SET 12

Weight= 1278.4 N Volume= 81.5 Litres
 Density= 1599.3 Kg/M³ Weight Factor= 1.210

Normal Stress(Pa)		Shear Stress/Friction Angle	
-158.5	-71.2	501.2 Pa	387.9 Pa
0.0	0.0	36.75 Deg	27.71 Deg
545.5	592.1		
971.4	1443.3		
1879.5	1685.6		
3973.2	3733.0	2034.6 Pa	1933.2 Pa
5239.5	5120.9	21.98 Deg	21.10 Deg
5821.2	6039.0		
5023.4	5198.4		
5377.0	4512.9		
3204.4	4118.4	1212.5 Pa	1381.9 Pa
8461.4	3124.8	25.89 Deg	26.97 Deg
2676.1	2767.7		
2157.9	2436.2		
1179.6	1173.0		

TEST 31 SET 13

Weight= 1148.2 N Volume= 73.4 Litres
 Density= 1594.6 Kg/M³ Weight Factor= 1.170

Normal Stress(Pa)		Shear Stress/Friction Angle	
-122.5	-68.8	295.9 Pa	242.4 Pa
-27.9	-53.2	42.00 Deg	33.86 Deg
223.1	299.8		
33.5	581.3		
1356.5	986.7		
3035.2	2908.7	1821.6 Pa	1752.8 Pa
4555.1	5172.4	23.29 Deg	20.22 Deg
4890.4	5837.2		
3687.1	5226.8		
5098.8	5112.9		
3183.3	3348.1	1147.4 Pa	1250.6 Pa
3771.9	3805.9	24.72 Deg	25.58 Deg
2646.1	2813.1		
1923.2	2193.5		
1140.2	1133.8		

APPENDIX E

THE FACTOR D IN WALKER'S THEORY

Refer to Fig. E.1. Walker's notation will be used.

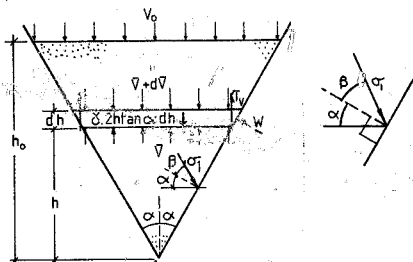


Figure E1 : Walker's theory

For vertical equilibrium

$$\gamma \cdot 2h \tan \alpha \, dh + d\bar{V} \cdot 2h \tan \alpha - \tau_v \cdot 2dh = 0 \quad \text{E.1}$$

$$\therefore \gamma + \frac{d\bar{V}}{dh} - \frac{\tau_v}{h \tan \alpha} = 0 \quad \text{E.2}$$

$$\tau_v = B \cdot V_w, \quad \text{(E.3)} \quad B = \frac{\sin \delta \sin 2(\alpha + \beta)}{1 - \sin \delta \cos 2(\alpha + \beta)} \quad \text{E.4}$$

$$V_w = D\bar{V} \quad \text{E.5}$$

From eqns. E.2, E.3 and E.5

$$\gamma + \frac{d\bar{V}}{dh} - \frac{BD}{h \tan \alpha} \cdot \bar{V} = 0$$

$$\text{Put } C = \frac{BD}{\tan \alpha} \quad \text{E.6}$$

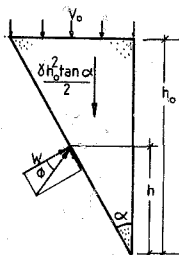


Figure E2. Vertical equilibrium of half of the bin

$$\therefore \gamma + \frac{d\bar{V}}{dh} - C \frac{\bar{V}}{h} = 0 \quad \text{E.7.}$$

The solution to X.7. is given by

$$\bar{V} = \frac{\gamma h}{C-1} \left[1 - \left(\frac{h}{h_0} \right)^{C-1} \right] + V_0 \left(\frac{h}{h_0} \right)^C \quad \text{E.8.}$$

Stress normal to the wall

$$W = E \cdot \bar{V} \quad \text{E.9.}$$

$$\text{where } E = \frac{1 + \sin \delta \cos 2\beta}{1 - \sin \delta \cos 2(\alpha + \beta)} \quad \text{E.10.}$$

Total load in half the bin, Fig. X.2 is

$$P = \frac{\gamma h_0^2}{2} \tan \alpha + V_0 \cdot h_0 \tan \alpha \quad \text{E.11.}$$

Also from the wall stresses

$$P = \int_0^{h_0} \frac{W}{\cos \phi} \sin (\phi + \alpha) \cdot \frac{dh}{\cos \alpha}$$

From eqn E.9.

$$P = \frac{E \sin(\phi+a)}{\cos\phi \cos a} \int_0^{h_0} \bar{V} \, dh \quad \text{E.12}$$

$$\text{Let } F = \frac{E \sin(\phi+a)}{\cos\phi \cos a} \quad \text{E.13}$$

$$\text{Then } P = F \int_0^{h_0} \bar{V} \, dh$$

$$\therefore P = F \int_0^{h_0} \left\{ \frac{\gamma h}{C+1} \left[1 - \left(\frac{h}{h_0} \right)^{C-1} \right] + V_0 \left(\frac{h}{h_0} \right)^C \right\} dh$$

$$\therefore P = \frac{F}{C+1} \left\{ \frac{\gamma h_0^2}{2} + V_0 h_0 \right\} \quad \text{E.14}$$

For the two expressions for the total load to be equal, from eqns E.11 and E.14.

$$\frac{F}{C+1} = \tan a$$

$$\therefore F = (C+1) \tan a$$

Substitute for F from eqn E.13, and E from eqn E.10 (from eqn E.6.) and B from eqn E.4. to get

$$\frac{\sin(\phi+a)}{\cos a \cos \phi} \cdot \frac{1 + \sin \delta \cos 2\beta}{1 - \sin \delta \cos 2(a+\beta)} \cdot D$$

$$= \left\{ \frac{\sin \delta \sin 2(a+\beta)}{1 - \sin \delta \cos 2(a+\beta)} \cdot \frac{D}{\tan a} + 1 \right\} \tan a$$

$$\text{for which } D = \frac{\sin a \cos \phi (1 - \sin \delta \cos 2(a+\beta))}{\sin(\phi+a) (1 + \sin \delta \cos 2\beta) - \sin \delta \sin 2(a+\beta) \cos a \cos \phi} \quad \text{E.15}$$

$$\text{where } \beta = \frac{1}{2} \left\{ \phi + a \sin \left[\frac{\sin a}{\sin \delta} \right] \right\} \quad \text{E.16}$$

Eqn E.15. was solved by computer and yielded $D = 1$ for all of the cases listed in table E.1.

Table E.1. Values of parameters for which $D = 1$:

α	30						30	45					
ϕ	20,1						30	20,1					
δ	33,8	30	40	50	25		31	40	50	30	40	50	

Therefore without further proof it seems that D must be equal to one for equilibrium.

APPENDIX F

BOOTH'S PILE THEORY⁽⁸⁾

With reference to Fig F1

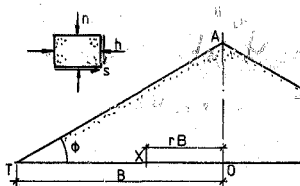


FIGURE F1 :Booth's pile theory

 ϕ = Internal friction = angle of repose (assumed equal) n = vertical pressure at X h = horizontal pressure at X s = shear stress at X γ = density $n = \gamma b (Ar^4 + Br^3 + Cr^2 + Dr + E)$

$$h = \frac{\gamma br^2}{\tan \phi} \left[\frac{2}{5} Ar^4 + \frac{3}{10} Br^3 + \frac{1}{6} Cr^2 \right] + k \gamma b E$$

$$s = \frac{\gamma br}{\tan \phi} \left[\frac{3}{5} Ar^4 + \frac{1}{2} Br^3 + \frac{1}{3} Cr^2 - E \right] + \gamma br$$

where $\rho = 1 + \sin \phi$

$$k = \frac{1 - \sin \phi}{1 + \sin \phi}$$

$$A = \frac{5}{2} \tan \phi - \frac{15}{4} \rho \tan \phi + 25 k E \tan \phi$$

$$B = -\frac{10}{3} \tan \phi + \frac{20}{3} \rho \tan \phi - \frac{160}{3} k E \tan \phi$$

$$C = -3 \rho \tan \phi + 30 k E \tan \phi$$

$$D = 0$$

$$E = \frac{\tan \phi \left(\frac{5}{6} + \frac{1}{12} \rho \right)}{1 + \frac{5}{3} k \tan \phi}$$

Table F1 gives values of the coefficients for different values of ϕ

Table F1 Stress distribution for $\phi = 30^\circ$

ϕ°	$\tan \phi$	p	k	A	B	C	E
38	0,781286	1,37904	0,23788	0,07825	-0,04092	-0,63383	0,59650
34	0,674509	1,31270	0,28272	0,04971	+0,06242	-0,63575	0,52362
30	0,577350	1,25000	0,33333	0,00564	+0,18042	-0,64275	0,45669

Stress distributions for $\phi = 30^\circ$ are shown in Fig F2

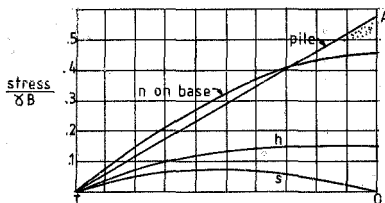


Figure F2 : Stress for $\phi = 30^\circ$

The assumptions are given in reference (8).

APPENDIX G

RADIAL STRESS FIELD⁽¹⁶⁾

The co-ordinate system is shown in Fig G1. A system of polar co-ordinates r and θ is used.

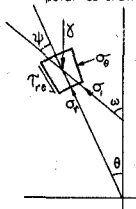


Figure G1
Co-ordinate System

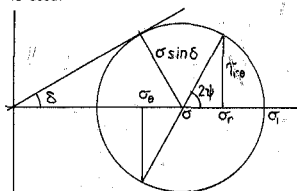


Figure G2
Mohr's circle at failure

The equations of equilibrium in polar co-ordinates are

$$\frac{r \partial \sigma_r}{\partial r} + \frac{r \partial \tau_{r\theta}}{\partial \theta} + \sigma_r - \sigma_\theta = \gamma \cos \theta \quad \text{G.1(a)}$$

$$\frac{r \partial \tau_{r\theta}}{\partial r} + \frac{\partial \sigma_\theta}{\partial \theta} + 2\tau_{r\theta} = \gamma \sin \theta \quad \text{G.1(b)}$$

The finity slip condition, Fig G2, is given by :

$$\sigma_r = \sigma (1 + \sin \delta \cos 2\psi) \quad \text{G.2(a)}$$

$$\sigma_\theta = \sigma (1 - \sin \delta \cos 2\psi) \quad \text{G.2(b)}$$

$$\tau_{r\theta} = \sigma \sin \delta \sin 2\psi \quad \text{G.2(c)}$$

APPENDIX G

RADIAL STRESS FIELD⁽¹⁶⁾

The co-ordinate system is shown in Fig G1. A system of polar co-ordinates r and θ is used.

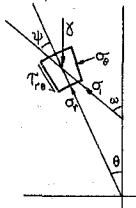


Figure G1

Co-ordinate System

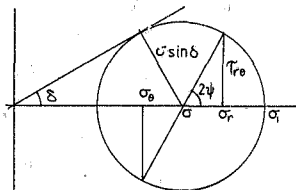


Figure G2

Mohr's circle at failure

The equations of equilibrium in polar co-ordinates are

$$\frac{r \partial \sigma_r}{\partial r} + \frac{r \partial \tau_{r\theta}}{\partial \theta} + \sigma_r - \sigma_\theta = \gamma r \cos \theta \quad G.1(a)$$

$$\frac{r \partial \tau_{r\theta}}{\partial r} + \frac{\partial \sigma_\theta}{\partial \theta} + 2\tau_{r\theta} = \gamma r \sin \theta \quad G.1(b)$$

The final slip condition, Fig G2, is given by :

$$\sigma_1 = \sigma (1 + \sin \delta \cos 2\psi) \quad G.2(a)$$

$$\sigma_3 = \sigma (1 - \sin \delta \cos 2\psi) \quad G.2(b)$$

$$\tau_{r\theta} = \sigma \sin \delta \sin 2\psi \quad G.2(c)$$

The assumptions for the radial stress field are

$$\sigma = \gamma r f(\theta) \quad G.3(a)$$

$$\psi = \psi(\theta) \quad G.3(b)$$

If eqns G.2 and G.3 are substituted in eqn G.1 the equations become total differential equations and can be shown to result in

$$\frac{d\psi}{d\theta} = -1 + \frac{(-\cos\theta + \sin\delta \cos(\theta + 2\psi) - f \cos^2\delta)}{2f \sin\delta (\cos 2\psi - \sin\delta)} \quad G.4(a)$$

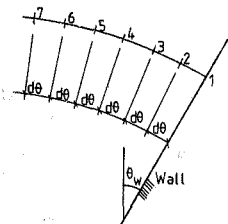
$$\text{and} \quad \frac{df}{d\theta} = \frac{\sin(2\psi + \theta) + f \sin 2\psi}{\cos(2\psi - \delta)} \quad G.4(b)$$

Eqns G.4 are solved numerically, starting at the wall ending at the centre. From the condition of slip at all ψ is known hence

$$\begin{aligned} \psi_w &= 90 + 0,5 \times (\psi_w + \text{asin}(\sin\psi_w / \sin\delta)) \\ &= 90 + .5 \times (20,1 + \text{asin}(\sin 20,1 / \sin 33,8)) \\ &= 119,2^\circ \end{aligned} \quad G.5$$

The value of f must be guessed at the wall. Then the derivatives at the wall can be found from eqn G.4. The solution proceeds in small steps of $d\theta$ towards the centre-line, so that θ is decreasing to zero.

Successive intervals starting at the wall are shown in Fig. G3. At point 2 a first order predictor is used, followed by a first order corrector, at point 3 a second order, etc. up to point 5. From point 5 onwards a fourth order Adams-Bashforth predictor is used followed by a fourth order corrector. The predictions are given in eqns G.6 for f . A similar set of equations is used for ψ .

Figure G.3 Increments of θ

First order	p	$f_2 = f_1 + f_1' d\theta$
	c	$f_2 = f_1 + (f_1' + f_1'') d\theta / 2$
Second order	p	$f_3 = f_2 + (3f_2' - f_1'') d\theta / 2$
	c	$f_3 = f_2 + (f_1' + f_2') d\theta / 2$
Third order	p	$f_4 = f_3 + (23f_3' - 16f_2'' + 5f_1''') d\theta / 12$
	c	$f_4 = f_3 + (5f_1' + 8f_2' - f_3'') d\theta / 12$
Fourth order	p	$f_5 = f_4 + (55f_4' - 59f_3'' + 37f_2''' - 9f_1''') d\theta / 24$
	c	$f_5 = f_4 + (9f_1' + 19f_2' - 5f_3' + f_4'') d\theta / 24$

where $f' = \frac{df}{d\theta}$

On reaching the centreline the value of ψ is checked to see if it is close enough to 90° . If not, another value of f is chosen at the wall and a second value of ψ is found at the centreline. Using these two sets of values a third value of f at the wall is predicted using a Newton-Raphson method, Fig G4.

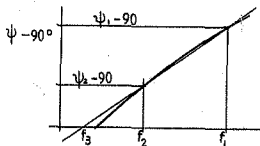


Figure G4 : Finding the root

$$f_3 = \frac{(\psi_2 - 90)f_1 - (\psi_1 - 90)f_2}{\psi_2 - \psi_1} \quad G.7$$

The calculation starting at the wall and ending at the centreline is repeated until ψ is close enough to 90° at the centreline. The end result is the required value of f at the wall.

Results for $\delta = 33,8^\circ$
 $\phi_w = 20,1^\circ$
 $\theta_w = 30^\circ$

successively small values of $\delta\theta$ were used to determine f , table G1.

TABLE G1 : Values of f

$\delta\theta$	5°	1°	$1,5^\circ$	$0,1^\circ$	$0,05^\circ$	$0,01^\circ$
f	1,0436	1,0341	1,0340	1,0309	1,0326	1,0337

The value for final use is $f = 1.034$.

The normal wall stress can then be found from eqn G.2(b).

$$\sigma = \gamma r f (1 - \sin \delta \cos 2\theta_w)$$

$$= \gamma r. 1.034 (1 - \sin 33.8 \cos (2 \times 119.2)) = 1.3354 \gamma r$$

The following program in BASIC carries out the calculation :

```

10  !RSFPC RADIAL STRESS FIELD WITH FOURTH ORDER
20  !PREDICTOR-CORRECTOR
30  PRINTER IS 701
40  De=33.8          !Delta
50  Fi=20.13         !Fi(wall)-Wall friction angle
60  Tw=30            !Wall angle to vertical
70  Tp=.01           !Tolerance in psi at centreline
80  INPUT "Dt=",Dt
90  Dr=.01745329*Dt  !dtheta.radians
100 /DEG
110 Pw=90+.5*(Fw+ASN(SIN(Fi)/SIN(De))) !Psi(wall)
120 C=COS(De)
130 S=SIN(De)
140 N=1              !Cycle number
150 GOTO 200
160 Dp=-1+(-COS(T)+S*COS(T+2*P)-F*C*C)/(2*F*S*(COS(2*P)-S))
170          !dpsi/dtheta
180 Df=(SIN(T+2*P)+F*SIN(2*P))/COS(2*P-De) !df/dtheta
190 RETURN
200 Fw=1             !Trial fw
210 P1=Pw
220 P=P1
230 F1=Fw
240 F=F1
250 T=Tw
260 GOSUB 160
270 Q1=Dp
280 H1=Df
290 T=T-Dt
300 P2=P1-Q1*Dt
310 F2=F1-H1*Dr
320 P=P2
330 F=F2
340 GOSUB 160
350 Q2=Dp
360 H2=Df

```

```

370 !P2=P1-(Q1+Q2)*Dt/2
380 !F2=F1-(H1+H2)*Dr/2
390 P3=P2-(3*Q2-Q1)*Dt/2
400 F3=F2-(3*H2-H1)*Dr/2
410 P=P3
420 F=F3
430 T=T-Dt
440 GOSUB 160
450 Q3=Dp
460 H3=Df
470 !P3=P2-(Q3+Q2)*Dt/2
480 !F3=F2-(H3+H2)*Dr/2
490 P4=P3-(23*Q3-16*Q2+5*Q1)*Dt/12
500 F4=F3-(23*H3-16*H2+5*H1)*Dr/12
510 P=P4
520 F=F4
530 T=T-Dt
540 GOSUB 160
550 Q4=Dp
560 H4=Df
570 !P4=P3-(5*Q4+8*Q3-Q2)*Dt/12
580 !F4=F3-(5*F4+8*F3-F2)*Dr/12
590 T=T-Dt
600 FOR T=T TO 0 STEP -Dt
610 P5=P4-(55*Q4-59*Q3+37*Q2-9*Q1)*Dt/24
620 F5=F4-(55*H4-59*H3+37*H2-9*H1)*Dr/24
630 P=P5
640 F=F5
650 GOSUB 160
660 Q5=Dp
670 H5=Df
680 !P5=P4-(9*Q5+19*Q4-5*Q3+Q2)*Dt/24
690 !F5=F4-(9*H5+19*H4-5*H3+H2)*Dr/24
700 P4=P5
710 Q1=Q2
720 Q2=Q3
730 Q3=Q4
740 Q4=Q5
750 F4=F5
760 H1=H2
770 H2=H3
780 H3=H4
790 H4=H5
800 NEXT T
810 PRINT IS 1
820 PRINT N,Fw,P5
830 IF P5<(90-Tp) AND P5<(90+Tp) THEN 970
840 IF N=1 THEN
850 Op=P5
!Old psi

```

```

860  Ofw=Fw                                !Old fw
870  N=N+1
880  Fw=Fw+.04
890  GOTO 210
900  END IF
910  I=Fw
920  Fw=Fw-(Fw-Ofw)/(P5-Dp)*(P5-90)
930  Dp=P5
940  Ofw=1
950  N=N+1
960  GOTO 210
970  PRINTER IS 701
980  PRINT TAB(16),"dtheta=";Dt;" deg    FW=";Fw
990  GOTO 80
1000 END

```

VARIABLE LIST

A	ψ_{n-3}
B	tolerance in ψ at centreline
C	$\cos \epsilon$
D	$d \theta$ (radians)
E	f_{wall}
F	$f(\theta)$
G	$d \theta$ (degrees)
H	f_{wall} (old value)
I	f_{wall} (temporary value)
J	ψ_{n-1}
K	f'_{n-1}
L	ψ_{n-2}
M	f'_{n-2}
N	cycle
O	ψ (old value at centreline)
P	ψ
Q	ψ_{wall}
R	2ψ
S	$\sin \epsilon$

G-8

T	θ
U	$10^{\circ}\theta$
V	δ : internal friction angle
W	ϕ_w : wall friction angle
X	ψ'_n
Y	f'_n
Z	f'_{n-3}
TW	θ (wall)

APPENDIX H

LEAST SQUARES FITTING PROGRAM

Equation to be fitted $y = a + bx + cx^2 + dx^3 + ex^4$

$$x_i = \text{ith } x \text{ co-ordinate} \quad (\text{H.1})$$

Let $Y_i = \text{observed value}$

$y_i = \text{calculated value from (H.1)}$

$$R_i = (Y_i - y_i) = \text{residual on error} \quad (\text{H.2})$$

$$S = \text{sum of squares of errors} = \sum R_i^2 \quad (\text{H.4})$$

$$\text{In order to minimise errors } \frac{\partial S}{\partial a} = 0 \quad (\text{H.4})$$

$$\therefore 2 \sum R_i \frac{\partial R_i}{\partial a} = 0 \quad (\text{H.5})$$

$$\therefore -\frac{1}{2} \frac{\partial S}{\partial a} = (a + bx_i + cx_i^2 + dx_i^3 + ex_i^4 - Y_i) 1 = 0$$

$$\therefore na + b \sum x_i + c \sum x_i^2 + d \sum x_i^3 + e \sum x_i^4 = \sum Y_i$$

similarly from :

$$\frac{\partial S}{\partial b} = 0 \quad a \sum x_i + b \sum x_i^2 + c \sum x_i^3 + d \sum x_i^4 + e \sum x_i^5 = \sum Y_i x_i$$

$$\frac{\partial S}{\partial c} = 0 \quad a \sum x_i^2 + b \sum x_i^3 + c \sum x_i^4 + d \sum x_i^5 + e \sum x_i^6 = \sum Y_i x_i^2$$

$$\frac{\partial S}{\partial d} = 0 \quad a \sum x_i^3 + b \sum x_i^4 + c \sum x_i^5 + d \sum x_i^6 + e \sum x_i^7 = \sum Y_i x_i^3$$

$$\frac{\partial S}{\partial e} = 0 \quad a \sum x_i^4 + b \sum x_i^5 + c \sum x_i^6 + d \sum x_i^7 + e \sum x_i^8 = \sum Y_i x_i^4$$

(H.6)

These five equations (H.6) can be solved for a, b, c, d and e.

APPENDIX I

THE METHOD OF CHARACTERISTICS ⁽¹⁶⁾⁽¹⁷⁾⁽¹⁸⁾⁽³⁸⁾⁽³⁹⁾

The co-ordinate system, stresses and direction of principal stress are shown in Fig I1. The circle of stress for Mohr-Coulomb failure is shown in Fig I2.

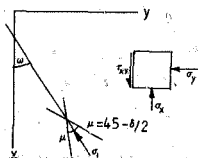


Figure I1
Stresses

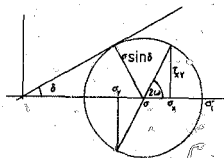


Figure I2
Mohr's circle at failure

the average direct stress is $\sigma = \frac{\sigma_x + \sigma_y}{2}$

From Fig I2: it can be seen that the Mohr-Coulomb law is equivalent to

$$\sigma_x = \sigma (1 + \sin \delta \cos 2w) \quad \text{I.1(a)}$$

$$\sigma_y = \sigma (1 - \sin \delta \cos 2w) \quad \text{I.1(b)}$$

$$\tau_{xy} = \sigma \sin \delta \sin 2w \quad \text{I.1(c)}$$

The equations of equilibrium in two dimensions under gravitational load are

$$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} = \gamma \quad \text{I.2(a)}$$

$$\frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \sigma_y}{\partial y} = 0 \quad \text{I.2(b)}$$

Substitute eqn I.1 into eqn I.2 :

The variables σ_x , σ_y , and τ_{xy} are then replaced by two variables σ and ω

$$\begin{aligned} (1 + \sin\delta \cos 2\omega) \frac{\partial \sigma}{\partial x} + \sin\delta \sin 2\omega \frac{\partial \sigma}{\partial y} - 2\sigma \sin\delta \sin \omega \frac{\partial \omega}{\partial x} \\ + 2\sigma \sin\delta \cos \omega \frac{\partial \omega}{\partial y} = \gamma \end{aligned} \quad \text{I.3(a)}$$

$$\sin\delta \sin 2\omega \frac{\partial \sigma}{\partial x} + (1 - \sin\delta \cos 2\omega) \frac{\partial \sigma}{\partial y} + 2\sigma \sin\delta \cos \omega \frac{\partial \omega}{\partial x} + 2\sigma \sin\delta \sin \omega \frac{\partial \omega}{\partial y} = 0$$

Make the substitutions $\sigma = \sigma_0 e^{(\xi + \eta) \tan \delta}$ I.3(b)

I.4(a)

$$2\omega = \xi - \eta \quad \text{I.4(b)}$$

$$\text{or } \left. \begin{aligned} \eta \end{aligned} \right\} = \frac{\cot \delta}{2} \cdot \ln \frac{\sigma}{\sigma_0} \mp \omega \quad \text{I.4(c)(d)}$$

$$\text{to get } \frac{\partial \eta}{\partial x} + \tan(\omega - \mu) \frac{\partial \eta}{\partial y} = a \quad \text{I.5(a)}$$

$$\frac{\partial \xi}{\partial x} + \tan(\omega + \mu) \frac{\partial \xi}{\partial y} = b \quad \text{I.5(b)}$$

$$\text{where } \left. \begin{aligned} a \\ b \end{aligned} \right\} = \frac{\gamma \sin(\omega \pm \mu)}{2\sigma \sin\delta \cos(\omega \pm \mu)} \quad \text{I.6}$$

The left hand sides of eqn I.5 are equivalent to total derivatives :

$$\frac{dy}{dx} = \frac{\partial \eta}{\partial x} + \frac{\partial \eta}{\partial y} \frac{dy}{dx} \quad \text{I.7(a)}$$

$$\frac{d\xi}{dx} = \frac{\partial \xi}{\partial x} + \frac{\partial \xi}{\partial y} \frac{dy}{dx} \quad \text{I.7(b)}$$

$$\text{where in I.7(a)} \quad \frac{dy}{dx} = \tan(\omega - \mu) \quad \text{I.8(a)}$$

$$\text{and in I.7(b)} \quad \frac{dy}{dx} = \tan(\omega + \mu) \quad \text{I.8(b)}$$

The directions defined by eqn I.8 are the directions in which total derivatives exist and are called characteristic directions. They are also the directions of the two families of slip lines, Fig I.1.

From eqns I.5 and I.7

$$\frac{dn}{dx} = a \quad \text{I.9(a)}$$

$$\frac{d\xi}{dx} = b \quad \text{I.9(b)}$$

along the slip lines.

Eqns I.8 and I.9 expressed in finite difference form are used to find a numerical solution to the slip line field. Eqns I.8 and I.9(a) refer to slip lines type 1 and eqns I.8(b) and I.9(b) refer to slip lines type 2, Fig I3.

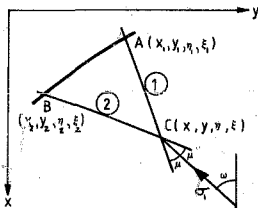


Figure I3

Points A and B are not on the same slip line.

From eqns I.8:

$$\frac{y - y_1}{x - x_1} = \tan(\omega_1 - \mu) = t_1 \quad \text{I.10(a)}$$

$$\frac{y - y_2}{x - x_2} = \tan(\omega_2 + \mu) = t_2 \quad \text{I.10(b)}$$

Solve eq I.10 for x and y

$$x = \frac{(y_2 - t_2 x_2) - (y_1 - t_1 x_1)}{t_1 - t_2} \quad \text{I.11(a)}$$

$$y = \frac{(y_2 - t_2 x_2) t_1 - (y_1 - t_1 x_1) t_2}{t_1 - t_2} \quad \text{I.11(b)}$$

from eqns I.9

$$\frac{y - y_1}{x - x_1} = a_1 \therefore \eta = \eta_1 + a_1(x - x_1) \quad \text{I.12(b)}$$

$$\frac{\xi - \xi_2}{x - x_2} = b_2 \therefore \xi = \xi_2 + b_2(x - x_2) \quad \text{I.12(b)}$$

Thus known conditions at A and B can be used to find co-ordinates x , η and ξ , and hence σ and ω at C. The eqns I.11 and I.12 are in their simplest form. Improvements can be made by averaging and iteration. The techniques for finding a new point vary on the centreline and on the wall. The location of discontinuities where two different slip line fields meet have to be determined. Along a discontinuity, Fig I4,

$$\sigma_{NA} = \sigma_{NB}$$

$$\tau_A = \tau_B$$

$$\sigma_{PA} \neq \sigma_{PB}$$

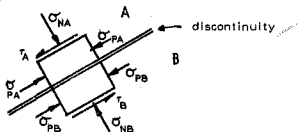


Figure I4

Stresses at a discontinuity

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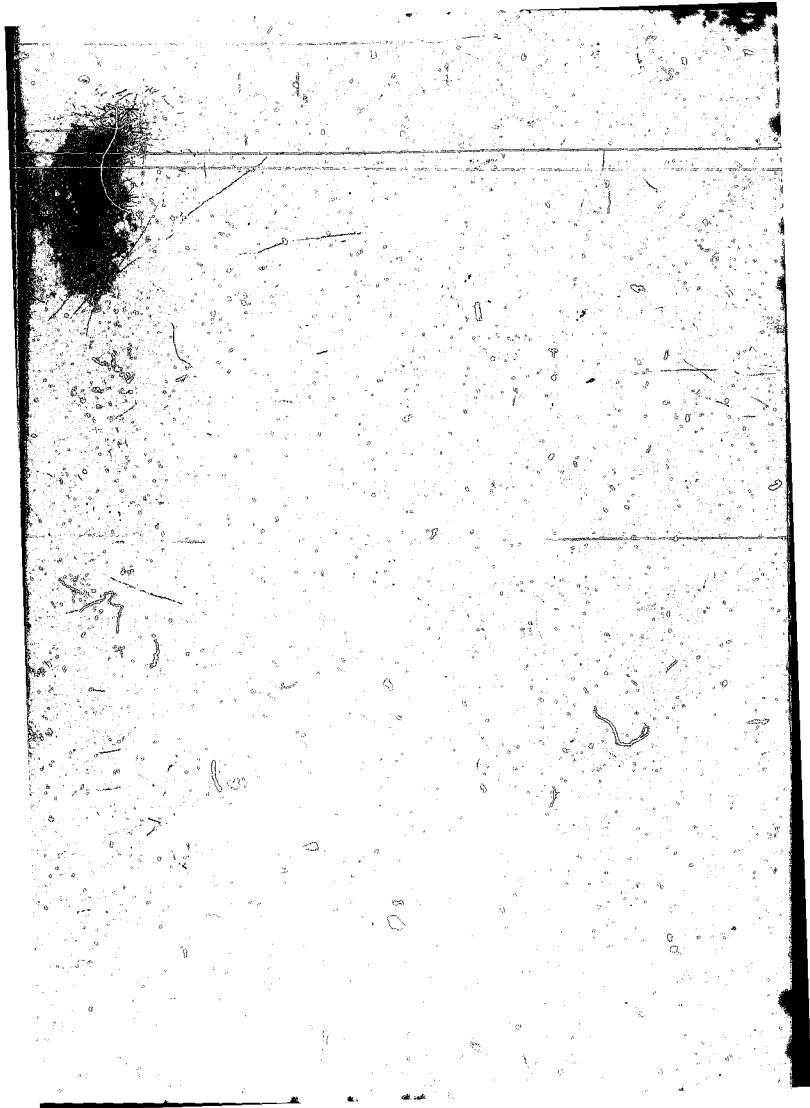
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