APPENDIX D

TYPICAL SAS INPUT FILE

Appendix D1: Notations used in the SAS model

Table A: Pilot Study (Degrees of Saturation):

Target Degree of Saturation, %	Y-Value
60	Y1
80	Y2
100	Y3

Table B: Pilot Study (Curing Durations):

Curing Duration, days	X-Value
28	X1
90	X2
180	X3

The tables A and B above presents the notations used in the statistical analysis for the pilot study. For each individual mix (i.e. Arusha, Mbeya and cement mixes), separate statistical analysis was performed.

Table C: Main Study (Degrees of Saturation):

Target Degree of Saturation, %	Y-Value
25	Y1
50	Y2
75	Y3
100	Y4

Table D: Main Study (Sand Type):

Sand Type	X-Value
Washed Sand	X1
Unwaashed Sand	X2

The tables C and D presents the notations used in the main study statistical analysis for each individual mix.

Appendices E and F provide the summaries of analysis for both Pilot and Main studies.

Appendix D2: Typical SAS input file (Pilot study - Arusha)

```
TITLE ARUSHA POZZOLAN A RANDOMIZED COMPLETE BLOCK (PILOT STUDY);
DATA RCB;
INPUT CUR MOIS $ DPTT UCS CBR DEN SHR;
CARDS;
1 69 693 8116 190 1974 -12.067
1 80 778 4915 90 2015 -13.482
1 100 1175 6744 25 2043 -14.467
1 120 1175 6744 25 2043 -14.467
1 69 941 7628 190 1968 -12.067
1 80 747 5019 90 1979 -13.482
1 105 1249 7007 25 2044 -14.467
1 120 1249 7007 25 2044 -14.467
1 69 774 8622 190 1970 -12.067
1 80 764 5310 90 2003 -13.482
1 105 1154 7100 25 2040 -14.467
1 120 1154 7100 25 2040 -14.467
3 69 1036 9775 190 1989 -12.067
3 80 1053 5898 90 1996 -13.482
3 105 1256 7435 25 2041 -14.467
3 120 1256 7435 25 2041 -14.467
3 69 1321 9061 190 1999 -12.067
3 80 954 5733 90 2016 -13.482
3 105 1042 10253 25 2041 -14.467
3 120 1042 10253 25 2041 -14.467
3 69 1148 10379 190 1993 -12.067
3 80 954 5914 90 2017 -13.482
3 105 1209 8100 25 2045 -14.467
3 120 1209 8100 25 2045 -14.467
6 69 862 12070 190 1977 -12.067
6 80 957 7446 90 2016 -13.482
6 105 1287 10022 25 2020 -14.467
6 120 1287 10022 25 2020 -14.467
6 69 1103 12273 190 1984 -12.067
6 80 862 6969 90 1988 -13.482
6 105 1249 10253 25 2041 -14.467
6 120 1249 10253 25 2041 -14.467
6 69 1002 11763 190 1969 -12.067
6 80 896 6969 90 2029 -13.482
6 105 1300 9303 25 2049 -14.467
6 120 1300 9303 25 2049 -14.467
9 69 862 12070 190 1977 -12.067
9 80 957 7446 90 2016 -13.482
9 105 1287 10022 25 2020 -14.467
9 120 1287 10022 25 2020 -14.467
9 69 1103 12273 190 1984 -12.067
9 80 862 6969 90 1988 -13.482
9 105 1249 10253 25 2041 -14.467
9 120 1249 10253 25 2041 -14.467
9 69 1002 11763 190 1969 -12.067
9 80 896 6969 90 2029 -13.482
9 105 1300 9303 25 2049 -14.467
9 120 1300 9303 25 2049 -14.467;
DATA RCB1;
SET RCB;
X1=0; X2=0; X3=0;
Y1=0; Y2=0; Y3=0;
```

```
IF MOIS=69 THEN Y1=1;
IF MOIS=80 THEN Y2=1;
IF MOIS=105 THEN Y3=1;
IF MOIS=120 THEN Y4=1;
IF CUR=1 THEN X1=1;
IF CUR=3 THEN X2=1;
IF CUR=6 THEN X3=1;
IF CUR=9 THEN X4=1;
RATIO = DPTT/UCS;
PROC GLM;
MODEL RATIO = X1 Y1 X2 Y2 X3 Y3
X1*Y1 X1*Y2 X1*Y3
X2*Y1 X2*Y2 X2*Y3
X3*Y1 X3*Y2 X3*Y3;
PROC GLM;
MODEL DPTT = X1 Y1 X2 Y2 X3 Y3
X1*Y1 X1*Y2 X1*Y3
X2*Y1 X2*Y2 X2*Y3
X3*Y1 X3*Y2 X3*Y3
;
PROC GLM;
MODEL UCS = X1 Y1 X2 Y2 X3 Y3
X1*Y1 X1*Y2 X1*Y3
X2*Y1 X2*Y2 X2*Y3
X3*Y1 X3*Y2 X3*Y3
;
PROC GLM;
MODEL DEN = X1 Y1 X2 Y2 X3 Y3
X1*Y1 X1*Y2 X1*Y3
X2*Y1 X2*Y2 X2*Y3
X3*Y1 X3*Y2 X3*Y3
;
PROC GLM;
MODEL CBR = Y1 Y2 Y3
;
PROC GLM;
MODEL SHR = Y1 Y2 Y3
;
PROC SORT DATA = RCB1; BY MOIS;
PROC MEANS DATA = RCB1;
BY MOIS;
VAR DPTT UCS DEN RATIO;
PROC SORT DATA = RCB1; BY CUR;
PROC MEANS;
BY CUR;
VAR DPTT UCS DEN RATIO;
PROC GLM DATA = RCB1;
CLASS MOIS CUR;
MODEL DPTT UCS DEN RATIO = MOIS CUR MOIS*CUR;
PROC GLM DATA = RCB1;
CLASS MOIS CUR;
MODEL DPTT UCS DEN SHR CBR RATIO = MOIS CUR MOIS*CUR;
MEANS MOIS/DUNCAN WALLER;
MEANS CUR/DUNCAN WALLER;
PROC PRINT DATA = RCB1;
RUN;
```

APPENDIX E: Summary of Pilot study SAS analysis

APPENDIX E1: ARUSHA POZZOLAN MIXES (PILOT STUDY)

ARUSHA UCS

PARAMETER	ESTIMATOR	X1	X2	Y1	Y2	X1*Y1	X1*Y2	X1*Y3	X2*Y1	X2*Y2	X2*Y3	X3*Y1	X3*Y2	X3*Y3
INTERCEPT	9859	9859	9859	9859	9859	9859	9859	9859	9859	9859	9859	9859	9859	9859
X1	-2909	-2909	0	0	0	-2909	-2909	-2909	0	0	0	0	0	0
X2	-1263	0	-1263	0	0	0	0	0	-1263	-1263	-1263	0	0	0
Y1	2176	0	0	2176		2176		0	2176	0	0	2176	0	0
Y2	-2731	0	0	0	-2731		-2731	0	0	-2731	0	0	-2731	0
X1*Y1	-1004	0	0	0	0	-1004	0	0	0	0	0	0	0	0
X1*Y2	862	0	0	0	0	0	862	0	0	0	0	0	0	0
X2*Y1	-1034	0	0	0	0	0	0	0	-1034	0	0	0	0	0
X2*Y2	-16	0	0	0	0	0	0	0	0	-16	0	0	0	0
Total		6950	8596	12035	7128	8122	5081	6950	9738	5848	8596	12035	7128	9859

ARUSHA DPTT

Parameter	Estimator	X1	X2	Y1	Y2	X1*Y1	X1*Y2	X1*Y3	X2*Y1	X2*Y2	X2*Y3	X3*Y1	X3*Y2	X3*Y3
Interceptor	1279	1279	1279	1279	1279	1279	1279	1279	1279	1279	1279	1279	1279	1279
X1	-86	-86	0	0	0	-86	-86	-86	0	0	0	0	0	0
X2	-110	0	-110	0	0	0	0	0	-110	-110	-110	0	0	0
Y1	-290	0	0	-290	0	-290	0	0	-290	0	0	-290	0	0
Y2	-374	0	0	0	-374	0	-374	0	0	-374	0	0	-374	0
X1*Y1	-100	0	0	0	0	-100	0	0	0	0	0	0	0	0
X1*Y2	-56	0	0	0	0	0	-56	0	0	0	0	0	0	0
X2*Y1	289	0	0	0	0	0	0	0	289	0	0	0	0	0
X2*Y2	192	0	0	0	0	0	0	0	0	192	0	0	0	0
TOTAL		1193	1169	989	905	803	763	1193	1168	987	1169	989	905	1279

ARUSHA DENSITY

PARAMETER	ESTIMATE	X1	X2	Y1	Y2	X1*Y1	X1*Y2	X1*Y3	X2*Y1	X2*Y2	X2*Y3	X3*Y1	X3*Y2	X3*Y3
INTERCEPT	2037	2037	2037	2037	2037	2037	2037	2037	2037	2037	2037	2037	2037	2037
X1	6	6	0	0	0	6	6	6	0	0	0	0	0	0
X2	6	0	6	0	0	0	0	0	6	6	6	0	0	0
Y1	-60	0	0	-60	0	-60	0	0	-60	0	0	-60	0	0
Y2	-26	0	0	0	-26	0	-26	0	0	-26	0	0	-26	0
X1*Y1	-12	0	0	0	0	-12	0	0	0	0	0	0	0	0
X1*Y2	-18	0	0	0	0	0	-18	0	0	0	0	0	0	0
X2*Y1	11	0	0	0	0	0	0	0	11	0	0	0	0	0
X2*Y2	-7	0	0	0	0	0	0	0	0	-7	0	0	0	0
TOTAL		2042	2042	1977	2011	1971	1999	2042	1994	2010	2042	1977	2011	2037

APPENDIX E2: MBEYA POZZOLAN MIXES (PILOT STUDY)

MBEYA DPTT

Parameter	Estimator	X1	X2	Y1	Y2	X1*Y1	X1*Y2	X1*Y3	X2*Y1	X2*Y2	X2*Y3	X3*Y1	X3*Y2	X3*Y3
Interceptor	1262	1262	1262	1262	1262	1262	1262	1262	1262	1262	1262	1262	1262	1262
X1	-751	-751	0	0	0	-751	-751	-751	0	0	0	0	0	0
X2	-266	0	-266	0	0	0	0	0	-266	-266	-266	0	0	0
Y1	-773	0	0	-773	0	-773	0	0	-773	0	0	-773	0	0
Y2	426	0	0	0	426	0	426	0	0	426	0	0	426	0
X1*Y1	506	0	0	0	0	506	0	0	0	0	0	0	0	0
X1*Y2	21	0	0	0	0	0	21	0	0	0	0	0	0	0
X2*Y1	230	0	0	0	0	0	0	0	230	0	0	0	0	0
X2*Y2	21	0	0	0	0	0	0	0	0	21	0	0	0	0
TOTAL		511	996	489	1688	244	958	511	453	1443	996	489	1688	1262

MBEYA UCS

PARAMETER	ESTIMATOR	X1	X2	Y1	Y2	X1*Y1	X1*Y2	X1*Y3	X2*Y1	X2*Y2	X2*Y3	X3*Y1	X3*Y2	X3*Y3
INTERCEPT	11040	11040	11040	11040	11040	11040	11040	11040	11040	11040	11040	11040	11040	11040
X1	-5746	-5746	0	0	0	-5746	-5746	-5746	0	0	0	0	0	0
X2	-2875	0	-2875	0	0	0	0	0	-2875	-2875	-2875	0	0	0
Y1	-5680	0	0	-5680	0	-5680	0	0	-5680		0	-5680	0	0
Y2	4270	0	0	0	4270		4270	0		4270	0	0	4270	0
X1*Y1	3930	0	0	0	0	3930	0	0	0	0	0	0	0	0
X1*Y2	-2169	0	0	0	0	0	-2169	0	0	0	0	0	0	0
X2*Y1	1933	0	0	0	0	0	0	0	1933	0	0	0	0	0
X2*Y2	-2239	0	0	0	0	0	0	0		-2239	0	0	0	0
Total		5294	8164	5360	15310	3544	7395	5294	4417	10196	8164	5360	15310	11040

MBEYA DENSITY

PARAMETER	ESTIMATE	X1	X2	Y1	Y2	X1*Y1	X1*Y2	X1*Y3	X2*Y1	X2*Y2	X2*Y3	X3*Y1	X3*Y2	X3*Y3
INTERCEPT	2097	2097	2097	2097	2097	2097	2097	2097	2097	2097	2097	2097	2097	2097
X1	-6	-6	0	0	0	-6	-6	-6	0	0	0	0	0	0
X2	-3	0	-3	0	0	0	0	0	-3	-3	-3	0	0	0
Y1	-155	0	0	-155	0	-155	0	0	-155	0	0	-155	0	0
Y2	-42	0	0	0	-42	0	-42	0	0	-42	0	0	-42	0
X1*Y1	23	0	0	0	0	23	0	0	0	0	0	0	0	0
X1*Y2	11	0	0	0	0	0	11	0	0	0	0	0	0	0
X2*Y1	-11	0	0	0	0	0	0	0	-11	0	0	0	0	0
X2*Y2	-1	0	0	0	0	0	0	0	0	-1	0	0	0	0
TOTAL		2092	2095	1942	2055	1959	2060	2092	1928	2052	2095	1942	2055	2097

APPENDIX E3: CEMENT MIXES (PILOT STUDY)

CEMENT UCS

PARAMETER	ESTIMATOR	X1	X2	Y1	Y2	X1*Y1	X1*Y2	X1*Y3	X2*Y1	X2*Y2	X2*Y3	X3*Y1	X3*Y2	X3*Y3
INTERCEPT	1357	1357	1357	1357	1357	1357	1357	1357	1357	1357	1357	1357	1357	1357
X1	-520	-520	0	0	0	-520	-520	-520	0	0	0	0	0	0
X2	-55	0	-55	0	0	0	0	0	-55	-55	-55	0	0	0
Y1	4704	0	0	4704	0	4704	0	0	4704	0	0	4704	0	0
Y2	2335	0	0	0	2335	0	2335	0	0	2335	0	0	2335	0
X1*Y1	-2184	0	0	0	0	-2184	0	0	0	0	0	0	0	0
X1*Y2	-662	0	0	0	0	0	-662	0	0	0	0	0	0	0
X2*Y1	-1861	0	0	0	0	0	0	0	-1861	0	0	0	0	0
X2*Y2	-604	0	0	0	0	0	0	0	0	-604	0	0	0	0
Total		837	1301	6061	3692	3357	2510	837	4144	3033	1301	6061	3692	1357

CEMENT DPTT

Parameter	Estimator	X1	X2	Y1	Y2	X1*Y1	X1*Y2	X1*Y3	X2*Y1	X2*Y2	X2*Y3	X3*Y1	X3*Y2	X3*Y3
Interceptor	191	191	191	191	191	191	191	191	191	191	191	191	191	191
X1	-134	-134	0	0	0	-134	-134	-134	0	0	0	0	0	0
X2	-54	0	-54	0	0	0	0	0	-54	-54	-54	0	0	0
Y1	558	0	0	558	0	558	0	0	558	0	0	558	0	0
Y2	194	0	0	0	194	0	194	0	0	194	0	0	194	0
X1*Y1	-314	0	0	0	0	-314	0	0	0	0	0	0	0	0
X1*Y2	-22	0	0	0	0	0	-22	0	0	0	0	0	0	0
X2*Y1	-163	0	0	0	0	0	0	0	-163	0	0	0	0	0
X2*Y2	6	0	0	0	0	0	0	0	0	6	0	0	0	0
TOTAL		58	137	749	385	301	230	58	532	336	137	749	385	191

CEMENT DENSITY

PARAMETER	ESTIMATE	X1	X2	Y1	Y2	X1*Y1	X1*Y2	X1*Y3	X2*Y1	X2*Y2	X2*Y3	X3*Y1	X3*Y2	X3*Y3
INTERCEPT	-1959	-1959	-1959	-1959	-1959	-1959	-1959	-1959	-1959	-1959	-1959	-1959	-1959	-1959
X1	-9	-9	0	0	0	-9	-9	-9	0	0	0	0	0	0
X2	-4	0	-4	0	0	0	0	0	-4	-4	-4	0	0	0
Y1	70	0	0	70	0	70	0	0	70	0	0	70	0	0
Y2	2	0	0	0	2	0	2	0	0	2	0	0	2	0
X1*Y1	22	0	0	0	0	22	0	0	0	0	0	0	0	0
X1*Y2	55	0	0	0	0	0	55	0	0	0	0	0	0	0
X2*Y1	-1	0	0	0	0	0	0	0	-1	0	0	0	0	0
X2*Y2	47	0	0	0	0	0	0	0	0	47	0	0	0	0
TOTAL		-1968	-1964	-1890	-1957	-1876	-1912	-1968	-1895	-1915	-1964	-1890	-1957	-1959

APPENDIX F: Summary of Main study SAS analysis

APPENDIX F1: ARUSHA POZZOLAN MIXES (MAIN STUDY)

UCS - Arusha Pozzolan Mixes

PARAMETER	ESTIMATOR	X1*Y1	X1*Y2	X1*Y3	X1*Y4	X1*Y5	X2*Y1	X2*Y2	X2*Y3	X2*Y4	X2*Y5
INTERCEPT	5303	5303	5303	5303	5303	5303	5303	5303	5303	5303	5303
X1*Y1	-5303	-5303	0	0	0	0	0	0	0	0	0
X1*Y2	-994	0	-994	0	0	0	0	0	0	0	0
X1*Y3	3366	0	0	3366	0	0	0	0	0	0	0
X1*Y4	-302	0	0	0	-302	0	0	0	0	0	0
X1*Y5	0	0	0	0	0	0	0	0	0	0	0
X2*Y1	-3676	0	0	0	0	0	-3676	0	0	0	0
X2*Y2	646	0	0	0	0	0	0	646	0	0	0
X2*Y3	3621	0	0	0	0	0	0	0	3621	0	0
X2*Y4	0	0	0	0	0	0	0	0	0	0	0
X2*Y5	0	0	0	0	0	0	0	0	0	0	0
		0	4309	8669	5001	5303	1627	5949	8924	5303	5303

DENSITY - Arusha Pozzolan Mixes

PARAMETER	ESTIMATOR	Y1	Y2	Y3	Y4	Y5
INTERCEPT	1954	1954	1954	1954	1954	1954
Y1	6	6	0	0	0	0
Y2	7	0	7	0	0	0
Y3	93	0	0	93	0	0
Y4	9	0	0	0	9	0
Y5	0	0	0	0	0	0
		1960	1962	2047	1963	1954

APPENDIX F2- MBEYA POZZOLAN MIXES (MAIN STUDY)

UCS - Mbeya Pozzolan Mixes

PARAMETER	ESTIMATOR	X1*Y1	X1*Y2	X1*Y3	X1*Y4	X2*Y1	X2*Y2	X2*Y3	X2*Y4
INTERCEPT	2003	2003	2003	2003	2003	2003	2003	2003	2003
X1*Y1	-1029	-1029	0	0	0	0	0	0	0
X1*Y2	4949	0	4949	0	0	0	0	0	0
X1*Y3	2333	0	0	2333	0	0	0	0	0
X1*Y4	957	0	0	0	957	0	0	0	0
X2*Y1	117	0	0	0	0	117	0	0	0
X2*Y2	4175	0	0	0	0	0	4175	0	0
X2*Y3	2144	0	0	0	0	0	0	2144	0
X2*Y4	0	0	0	0	0	0	0	0	0
		974	6952	4336	2960	2120	6178	4147	2003

DENSITY - Mbeya Pozzolan Mixes

PARAMETER	ESTIMATOR	Y1	Y2	Y3	Y4	Y5
INTERCEPT	1954	1954	1954	1954	1954	1954
Y1	6	6	0	0	0	0
Y2	7	0	7	0	0	0
Y3	93	0	0	93	0	0
Y4	9	0	0	0	9	0
Y5	0	0	0	0	0	0
		1960	1962	2047	1963	1954

APPENDIX F3: CEMENT MIXES (MAIN STUDY)

UCS - Cement Mixes

PARAMETER	ESTIMATOR	X1*Y1	X1*Y2	X1*Y3	X1*Y4	X2*Y1	X2*Y2	X2*Y3	X2*Y4
INTERCEPT	1758	1758	1758	1758	1758	1758	1758	1758	1758
X1*Y1	-1672	-1672	0	0	0	0	0	0	0
X1*Y2	1278	0	1278	0	0	0	0	0	0
X1*Y3	1859	0	0	1859	0	0	0	0	0
X1*Y4	360	0	0	0	360	0	0	0	0
X2*Y1	620	0	0	0	0	620	0	0	0
X2*Y2	3666	0	0	0	0	0	3666	0	0
X2*Y3	1566	0	0	0	0	0	0	1566	0
X2*Y4	0	0	0	0	0	0	0	0	0
		86	3036	3617	2118	2378	5424	3324	1758

DENSITY - Cement Mixes

PARAMETER	ESTIMATOR	Y1	Y2	Y3	Y4	Y5
INTERCEPT	1954	1954	1954	1954	1954	1954
Y1	6	6	0	0	0	0
Y2	7	0	7	0	0	0
Y3	93	0	0	93	0	0
Y4	9	0	0	0	9	0
Y5	0	0	0	0	0	0
		1960	1962	2047	1963	1954