



**Report No. 1035**

# **Concrete Proficiency Testing Program**

**Round 22**

**August 2017**

## **Acknowledgments**

PTA wishes to gratefully acknowledge the technical assistance provided for this program and for the supply and distribution of the samples by Mr M Rheinberger from Soil Engineering Services, Brisbane QLD.

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## 1. FOREWORD

This report summarises the results of a proficiency testing program on the determination of Density and Compressive Strength of hardened concrete cylinders. It constitutes the twenty second round of an ongoing series of programs.

The program was conducted in May 2017 by Proficiency Testing Australia (PTA). The aim of the program was to assess laboratories' abilities to competently perform the prescribed analyses.

The Program Coordinator was Ms S To and the Technical Adviser was Mr M Rheinberger. This report was authorised by Mr P Briggs, PTA General Manager.

## 2. FEATURES OF THE PROGRAM

- (a) Participants were provided with two concrete cylinders labelled PTA 1 and PTA 2.
- (b) A total of 57 laboratories received samples, comprising:
  - 42 Australian participants; and
  - 15 overseas participants, including:
    - Colombia (4)
    - Malaysia (2)
    - Mauritius (2)
    - New Zealand (2)
    - Peru (1)
    - Philippines (3)
    - South Korea (1)

Of these 57 laboratories, 2 laboratories were unable to submit results by the due date.

- (c) Laboratories were provided with the *Instructions to Participants* and *Results Sheet* (see Appendix C). Laboratories were requested to perform the tests according to their routine methods and to record their results on the *Results Sheet*.
- (d) Prior to sample distribution, a number of randomly selected samples were analysed for homogeneity. Based on the results of this testing (see Appendix B), the homogeneity of the samples was established.

- (e) Each laboratory was randomly allocated a unique code number for the program to ensure confidentiality of results. Reference to each laboratory in this report is by code number only. Please note that a number of laboratories reported more than one set of results and, therefore, their code numbers (with letter) could appear several times in the same data set.
- (f) Results (as reported by participants) with corresponding summary statistics (i.e. number of results, median, uncertainty of the median, normalised interquartile range, robust coefficient of variation, minimum, maximum and range) are presented in Appendix A (for each sample and for each of the analyses performed).
- (g) A robust statistical approach, using z-scores, was utilised to assess laboratories' testing performance (see Section 4). Robust z-scores, z-score charts relevant to each test are presented in Appendix A.
- (h) The document entitled *Guide to Proficiency Testing Australia, 2016* (reference [1]) defines the statistical terms and details the statistical procedures referred to in this report.
- (i) A tabulated listing of laboratories (by code number) identified as having outlier results can be found on page 8.

### **3. FORMAT OF THE APPENDICES**

- (a) Appendix A contains the analysis of results reported by laboratories for the samples. This section contains the following for each determinant, where appropriate:
  - A table of results and calculated z-scores;
  - A list of summary statistics; and
  - Ordered z-score charts.
- (b) Appendix B contains details of the homogeneity and stability testing.
- (c) Appendix C contains copies of the *Instructions to Participants and Results Sheet*.

#### 4. STATISTICAL DESIGN OF THE PROGRAM

##### (a) Outlier Results and Z-scores

In order to assess laboratories' testing performance, a robust statistical approach, using z-scores, was utilised. Z-scores give a measure of how far a result is from the consensus value (i.e. the median), and gives a "score" to each result relative to the other results in the group.

A z-score close to zero indicates that the result agrees well with those from other laboratories, whereas a z-score with an absolute value greater than or equal to 3.0 is considered to be an outlier and is marked by the symbol "§".

The table on page 8 summarises the outlier results detected.

##### (b) Results Tables and Summary Statistics

Each of these tables contains the results returned by each laboratory, including the code number for the method used, and the robust z-score calculated for each result.

Results have been entered exactly as reported by participants. That is, laboratories which did not report results to the precision (i.e. number of decimal places) requested on the Results Sheet have **not** been rounded to the requested precision before being included in the statistical analysis.

A list of summary statistics appears at the bottom of each of the tables of results and consists of:

- The number of results for that test/sample (*No. of Results*);
- The median of these results, i.e. the middle value (*Median*);
- The uncertainty of the median; a robust estimate of the standard deviation of the *Median*;
- The normalised interquartile range of the results (*Normalised IQR*);
- The robust coefficient of variation, expressed as a percentage (*Robust CV*) - i.e.  $100 \times \text{Normalised IQR} / \text{Median}$ ;
- The minimum and maximum laboratory results; and
- The range (*Maximum - Minimum*).

The median is a measure of the centre of the data.

The normalised IQR is a measure of the spread of the results. It is calculated by multiplying the interquartile range (IQR) by a correction factor which converts the IQR to an estimate of the standard deviation. The IQR is the difference between the upper and lower quartiles (i.e. the values above and below which a quarter of the results lie, respectively).

For normally distributed data, the uncertainty of the median is approximated by:

$$\sqrt{\frac{\pi}{2}} \times \frac{\text{normIQR}}{\sqrt{n}} \quad n = \text{number of results}$$

Please see reference [1] for further details on these robust summary statistics.

(c) Ordered Z-Score Charts

On these charts each laboratory's robust z-score is shown, in order of magnitude, and is marked with its code number. From these charts, each laboratory can readily compare its performance relative to the other laboratories.

These charts contain solid lines at +3.0 and -3.0, so that outliers are clearly identifiable as those laboratories whose "bar" extends beyond these "cut-off" lines. The y-axis of these charts has been limited, so very large z-scores appear to extend beyond the chart boundary.

The following table summarises the results submitted by participants for the program.

**TABLE A - 1: SUMMARY STATISTICS**

<b>Test</b>	<b>No. of Results</b>	<b>Median</b>	<b>Minimum</b>	<b>Maximum</b>
Height - PTA 1 (Nearest 1mm)	60	199.6	196	201
Height - PTA 2 (Nearest 1mm)	60	199.0	197	200
Diameter PTA 1 (Nearest 0.2mm)	60	100.10	99.9	100.5
Diameter PTA 2 (Nearest 0.2mm)	60	100.10	99.8	100.6
Weight PTA 1 (Nearest 1g)	60	3858.5	3472	3888
Weight PTA 2 (Nearest 1g)	60	3785.0	3710	3874
Maximum Sustained Load Unit PTA 1 (Nearest 1 kN)	60	370.5	279	437
Maximum Sustained Load Unit PTA 2 (Nearest 1 kN)	60	433.0	287	501

**TABLE A - 2: SUMMARY STATISTICS**

<b>Test</b>	<b>No. of Results</b>	<b>Median</b>	<b>Normalised IQR</b>	<b>Robust CV (%)</b>
Mass/Volume PTA 1 (Nearest 1kg/m <sup>3</sup> )	60	2461.5	17.2	0.7
Mass/Volume PTA 2 (Nearest 1kg/m <sup>3</sup> )	60	2420.0	13.2	0.1
Compressive Strength PTA 1 (Nearest 0.1 MPa)	60	47.10	2.69	5.7
Compressive Strength PTA 2 (Nearest 0.1 MPa)	60	55.05	3.73	6.8

## 5. PTA AND TECHNICAL ADVISER'S COMMENTS

A total of 57 laboratories participated in this round.

A number of laboratories received their samples late and could not perform testing on the requested date. (see "Date of Tests" information supplied in Appendix A). This may have effected Compressive Strength and Mass/Volume results. Internal cylinder damage may be possible from shipping, however, this is untraceable and unlikely as it requires an extreme impact for this to occur.

Overall, 15 outliers were detected from the 240 results analysed, resulting in 6.25% of results classified as outliers.

Laboratories with a symbol "?" or "§" are recommended to review their procedures and test methods.

Participants should take care when recording results and note the units and calculations on the provided Results Sheet.

Participants may consider the following when performing corrective action investigations:

- Training of technicians
- Calibration of equipment
- Review of methods and procedures
- Ground end inspection checked daily, randomly or 1 in 20 specimen checks
- Precision in reporting and calculations

### Metrological Traceability and Measurement Uncertainty of Assigned Values

Consensus values (median) derived from participants' results are used in this program. These values are not metrologically traceable to an external reference.

Sample preparation was undertaken according to Standard Operating Procedures of Soil Engineering Services to ensure samples were homogenous and adequate for the program. Please refer to Appendix B for homogeneity results.

As the assigned value for this program is the median of the results submitted by the participants, the uncertainty of the median has been calculated and is presented in Appendix A.



### Analysis of Results by Method Groups

Further analysis of results by method groups was undertaken to provide specific information on individual method performance.

In order for methods to be grouped for analysis, PTA requires at least 11 sets of results from the same method group. For methods other than those presented below, there were less than 11 results submitted for each method, therefore reliable conclusions cannot be drawn from analysing them separately on this occasion.

The method AS1012.9 was the most frequently employed for Compressive Strength testing. Table B below presents the Median, Uncertainty of the Median and Robust CV for Compressive Strength results obtained by the AS1012.9 method.

**TABLE B: SUMMARY OF GROUP ANALYSIS**

Analysis	Sample	Number of Participants	Median	Uncertainty of the Median	Robust CV (%)
Compressive Strength (Nearest 0.1MPa)	PTA 1	38	47.20	0.47	4.9
	PTA 2	38	55.40	0.73	6.5

## 6. OUTLIER RESULTS

Laboratories reporting outlier results are listed in the following table:

**TABLE B: SUMMARY OF STATISTICAL OUTLIERS**

Test	Laboratory Code No.
Mass/Volume PTA 1 (Nearest 1kg/m <sup>3</sup> )	52B, 61, 78
Mass/Volume PTA 2 (Nearest 1kg/m <sup>3</sup> )	61, 78
Compressive Strength PTA 1 (Nearest 0.1 MPa)	50, 51, 76, 92, 100
Compressive Strength PTA 2 (Nearest 0.1 MPa)	50, 51, 61, 92, 96

**TABLE C: PERCENTAGE OF OUTLIERS**

Test	Percentage Outliers (%)
Mass/Volume PTA 1 (Nearest 1kg/m <sup>3</sup> )	5
Mass/Volume PTA 2 (Nearest 1kg/m <sup>3</sup> )	3.3
Compressive Strength PTA 1 (Nearest 0.1 MPa)	8.3
Compressive Strength PTA 2 (Nearest 0.1 MPa)	8.3

## 7. REFERENCES

- [1] *Guide to Proficiency Testing Australia*, 2016 (This document can be found on the PTA website, [www.pta.asn.au](http://www.pta.asn.au))
- [2] AS 1012.9 - 2014 *Methods of testing concrete. Method 9: Compressive Strength Tests - Concrete, mortar and grout specimens*

# APPENDIX A

## Results and Data Analysis

Height (Nearest 1mm).....	A1
Diameter (Nearest 0.2mm).....	A2
Weight (Nearest 1g).....	A4
Maximum Sustained Load Unit (Nearest 1kN).....	A5
Mass/Volume (Nearest 1kg/m <sup>3</sup> ).....	A7
Compressive Strength (Nearest 0.1MPa).....	A11
Other Information.....	A16

## A1

Lab Code	Height (Nearest 1mm)	
	PTA 1	PTA 2
5	200	199
11	199	199
14A	200	200
14B	200	200
16	200	199
18	198	198
19	200.0	200.0
21	199	198
22	200	199
24	200	200
28A	199	199
28B	200	199
30	200	199
33	199	199
39	200	199
40	200	200
41	200	198.0
42	200	200
43	199	199
47	199	198
50	199.3	199.2
51	199	200
52A	200	200
52B	200	199
54A	197	197
54B	197	197
55	196	197
57	199	198
59	198.0	198.00
60	199.8	199.8
61	200	200
65	200	199
67	200	200
69	197	197
71	200	199
72	199.0	199.0
73	199	199
74	200	200
76	199	199
77	201	199
78	199	200
80	198	197
81	199	199
82	200	199
83A	199	197
83B	199	197
83C	197	198
84	197	197
85	199	199
86	199	198
88	200	198
91	199	199
92	200	199
93	197	197
94	200	199
96	200.2	199.8
97	199	199
98	200.0	198.0
99	200	199
100	200	199

Lab Code	Diameter PTA 1 (Nearest 0.2mm)			Lab Code	Diameter PTA 1 (Nearest 0.2mm)		
	Result 1	Result 2	Average		Result 1	Result 2	Average
5	100.0	100.0	100.0	61	100.2	100.0	100.1
11	100.1	100.1	100.1	65	100.2	100.0	100.1
14A	100.2	99.8	100.0	67	100.1	100.1	100.1
14B	99.8	100.2	100.0	69	99.8	100.2	100.0
16	100.2	100.0	100.1	71	100.4	99.8	100.1
18	100.0	100.2	100.1	72	100.0	100.0	100.0
19	99.8	100.0	99.9	73	100.4	100.4	100.4
21	100.0	100.2	100.1	74	99.8	100.3	100.1
22	100.0	99.8	99.9	76	99.8	100.2	100.0
24	99.8	100.0	99.9	77	99.8	100.2	100.0
28A	99.8	100.2	100.0	78	99.8	100.2	100.0
28B	100.2	100.0	100.1	80	100.4	99.8	100.1
30	100.2	100.4	100.3	81	100.0	100.2	100.1
33	100.1	100.2	100.2	82	99.8	100.0	99.9
39	100.0	100.2	100.1	83A	100.0	100.0	100.0
40	100.0	100.0	100.0	83B	100.0	100.0	100.0
41	100.6	100.0	100.3	83C	100.0	100.0	100.0
42	100.0	100.2	100.1	84	99.8	100.4	100.1
43	100.0	100.4	100.2	85	100.4	100.0	100.2
47	100.0	100.4	100.2	86	100.0	100.2	100.1
50	99.8	100.3	100.1	88	100.4	99.8	100.1
51	99.8	100.0	99.9	91	100.4	99.8	100.1
52A	100.4	100.4	100.4	92	100.2	100.0	100.1
52B	100.0	100.0	100.0	93	100.3	100.0	100.2
54A	100.2	100.2	100.2	94	100.4	100.2	100.3
54B	100.0	100.2	100.1	96	100.4	100.4	100.4
55	100.0	99.8	99.9	97	100.0	100.2	100.1
57	100.0	100.0	100.0	98	100.0	100.0	100.0
59	100.2	100.6	100.4	99	100.0	100.0	100.0
60	100.8	100.2	100.5	100	100.2	100.2	100.2

Lab Code	Diameter PTA 2 (Nearest 0.2mm)			Lab Code	Diameter PTA 2 (Nearest 0.2mm)		
	Result 1	Result 2	Average		Result 1	Result 2	Average
5	100.0	100.0	100.0	61	100.2	100.0	100.1
11	100.0	100.0	100.0	65	100.2	100.0	100.1
14A	99.8	100.2	100.0	67	100.1	99.9	100.0
14B	100.2	99.8	100.0	69	99.8	100.2	100.0
16	100.4	100.2	100.3	71	100.0	100.4	100.2
18	100.2	100.0	100.1	72	100.0	100.0	100.0
19	100.6	100.6	100.6	73	100.4	100.2	100.3
21	100.0	100.4	100.2	74	99.8	100.3	100.1
22	100.0	100.0	100.0	76	100.0	100.4	100.2
24	100.0	100.0	100.0	77	100.2	99.8	100.0
28A	99.8	100.4	100.1	78	100.8	100.0	100.4
28B	100.2	100.0	100.1	80	100.4	99.8	100.1
30	100.2	100.2	100.2	81	99.8	100.2	100.0
33	100.0	100.2	100.1	82	99.8	100.0	99.9
39	100.2	100.2	100.2	83A	100.0	100.0	100.0
40	100.0	100.2	100.1	83B	100.0	100.0	100.0
41	100.0	100.4	100.2	83C	100.0	100.0	100.0
42	100.4	100.2	100.3	84	99.8	100.4	100.1
43	99.6	100.2	99.9	85	100.4	100.4	100.4
47	100.0	100.2	100.1	86	100.2	100.0	100.1
50	99.9	100.2	100.1	88	100.2	100.0	100.1
51	100.0	100.0	100.0	91	100.4	99.8	100.1
52A	100.2	100.2	100.2	92	100.0	100.1	100.1
52B	100.0	100.0	100.0	93	100.3	100.1	100.2
54A	100.0	100.2	100.1	94	100.2	100.0	100.1
54B	100.0	100.2	100.1	96	100.2	100.2	100.2
55	99.8	99.8	99.8	97	100.0	100.2	100.1
57	100.0	100.0	100.0	98	100.2	100.2	100.2
59	100.6	100.2	100.4	99	100.2	100.2	100.2
60	99.9	100.6	100.3	100	100.0	100.0	100.0

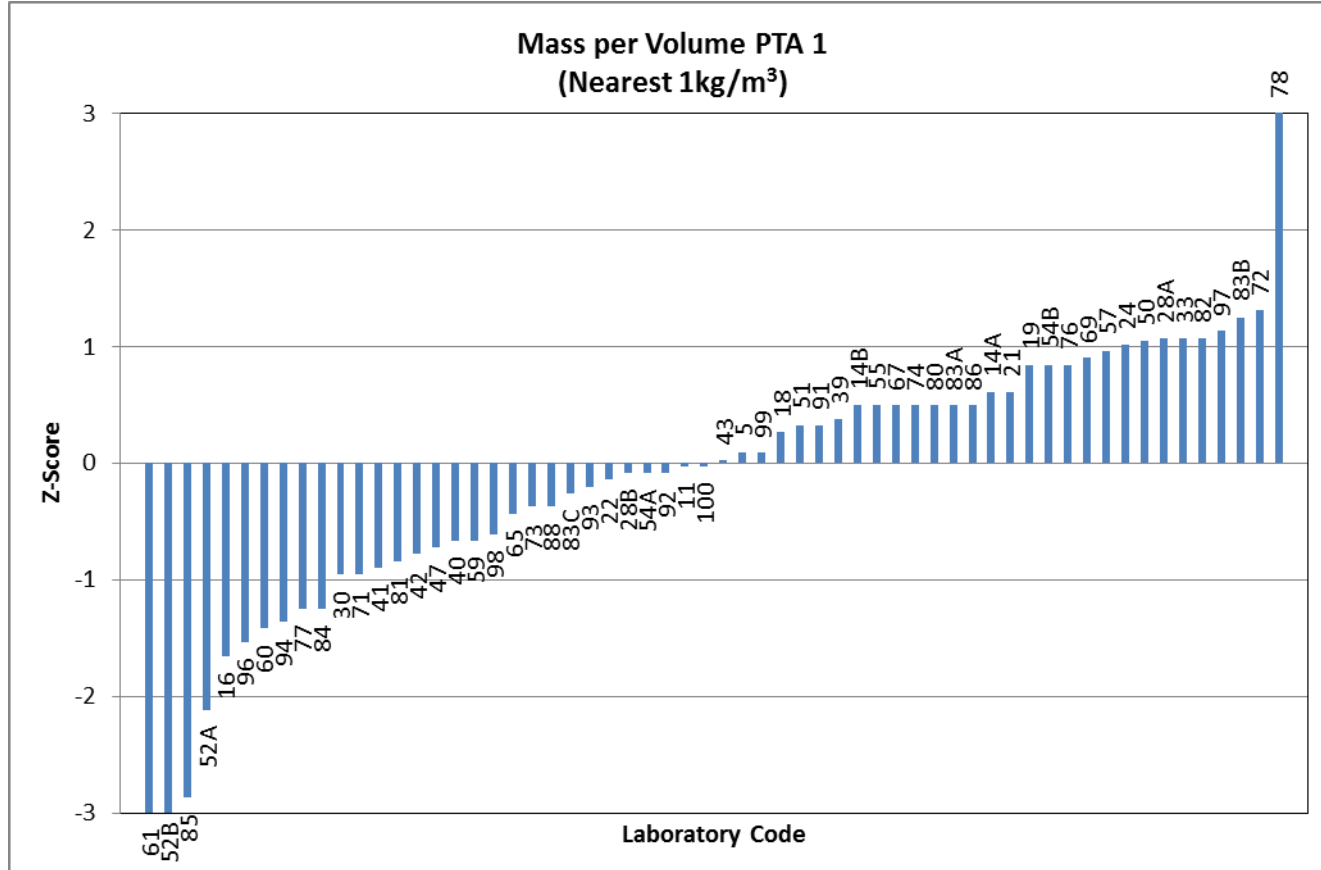
Lab Code	Weight (Nearest 1g)	
	PTA 1	PTA 2
5	3869	3807
11	3854	3776
14A	3888	3796
14B	3880	3783
16	3830	3777
18	3850	3777
19	3881	3788
21	3872	3797
22	3855	3810
24	3886	3775
28A	3878	3807
28B	3874	3793
30	3863	3787
33	3884	3793
39	3884	3819
40	3848	3797
41	3865	3765
42	3857	3791
43	3865	3766
47	3843	3781
50	3868	3750
51	3841	3794
52A	3842	3874
52B	3777	3792
54A	3821	3761
54B	3837	3760
55	3790	3710
57	3873	3773
59	3841.0	3758.0
60	3850	3783
61	3472	3789
65	3835	3822
67	3871	3784
69	3833	3748
71	3848	3801
72	3883.0	3785.0
73	3866	3777
74	3888	3772
76	3870	3797
77	3852	3773
78	3839	3795
80	3849	3754
81	3852	3801
82	3883	3795
83A	3861	3761
83B	3881	3721
83C	3802	3785
84	3795	3745
85	3781	3856
86	3864	3774
88	3864	3776
91	3863	3811
92	3868	3813
93	3806	3746
94	3854	3776
96	3860	3787
97	3885	3818
98	3850.0	3796.0
99	3869	3803
100	3846	3782

Lab Code	Maximum Sustained Load Unit (Nearest 1kN)	
	PTA 1	PTA 2
5	367	402
11	386	461
14A	334	404
14B	345	407
16	372	419
18	394	466
19	375	430
21	347.1	401.7
22	377	442
24	366	438
28A	389	451
28B	375	462
30	367	436
33	393	400
39	359	444
40	352	436
41	373	439
42	408	486
43	368	398
47	382	450
50	301.3	286.6
51	290	340
52A	369	361
52B	425	414
54A	368	423
54B	350	413
55	371	457
57	383	440
59	391.0	473.0
60	396.9	464.9
61	316	338
65	370	448
67	380	442
69	379	454
71	320	410
72	419.8	500.6
73	375.0	419.7
74	374	451
76	290	415
77	356	417
78	387	457
80	390	452
81	354	439
82	376	426
83A	360	410
83B	358	407
83C	361	412
84	333	424
85	430	373
86	337	408
88	398	434
91	385.6	432.9
92	279	292
93	372	446
94	368	433
96	339	344
97	376	435
98	368.0	416.0
99	350	442
100	437	469

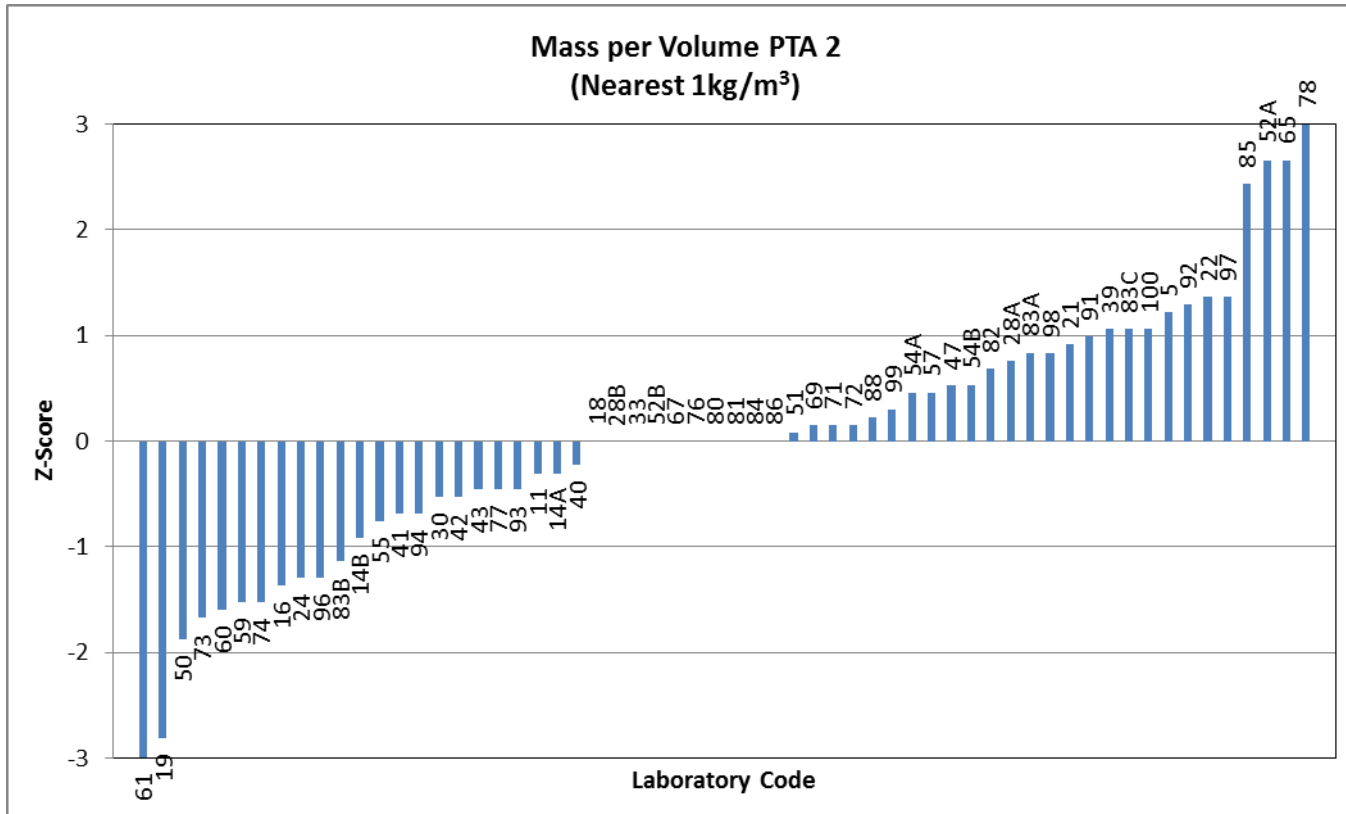


<b>Test</b>	<b>No. of Results</b>	<b>Median</b>	<b>Minimum</b>	<b>Maximum</b>
Height - PTA 1 (Nearest 1mm)	60	199.6	196	201
Height - PTA 2 (Nearest 1mm)	60	199.0	197	200
Diameter PTA 1 (Nearest 0.2mm)	60	100.10	99.9	100.5
Diameter PTA 2 (Nearest 0.2mm)	60	100.10	99.8	100.6
Weight PTA 1 (Nearest 1g)	60	3858.5	3472	3888
Weight PTA 2 (Nearest 1g)	60	3785.0	3710	3874
Maximum Sustained Load Unit PTA 1 (Nearest 1kN)	60	370.5	279	437
Maximum Sustained Load Unit PTA 2 (Nearest 1kN)	60	433.0	287	501

Lab Code	Mass/Volume PTA 1 (Nearest 1kg/m <sup>3</sup> )		Lab Code	Mass/Volume PTA 1 (Nearest 1kg/m <sup>3</sup> )	
	Result	Z-Score		Result	Z-Score
5	2463	0.09	61	2170	-16.91 §
11	2461	-0.03	65	2454	-0.44
14A	2472	0.61	67	2470	0.49
14B	2470	0.49	69	2477	0.90
16	2433	-1.65	71	2445	-0.96
18	2466	0.26	72	2484	1.31
19	2476	0.84	73	2455	-0.38
21	2472	0.61	74	2470	0.49
22	2459	-0.15	76	2476	0.84
24	2479	1.02	77	2440	-1.25
28A	2480	1.07	78	2559	5.66 §
28B	2460	-0.09	80	2470	0.49
30	2445	-0.96	81	2447	-0.84
33	2480	1.07	82	2480	1.07
39	2468	0.38	83A	2470	0.49
40	2450	-0.67	83B	2483	1.25
41	2446	-0.90	83C	2457	-0.26
42	2448	-0.78	84	2440	-1.25
43	2462	0.03	85	2412	-2.87 ?
47	2449	-0.73	86	2470	0.49
50	2479.49	1.04	88	2455	-0.38
51	2467	0.32	91	2467	0.32
52A	2425	-2.12 ?	92	2460	-0.09
52B	2404	-3.34 §	93	2458	-0.20
54A	2460	-0.09	94	2438	-1.36
54B	2476	0.84	96	2435	-1.54
55	2470	0.49	97	2481	1.13
57	2478	0.96	98	2451	-0.61
59	2450.0	-0.67	99	2463	0.09
60	2437	-1.42	100	2461	-0.03

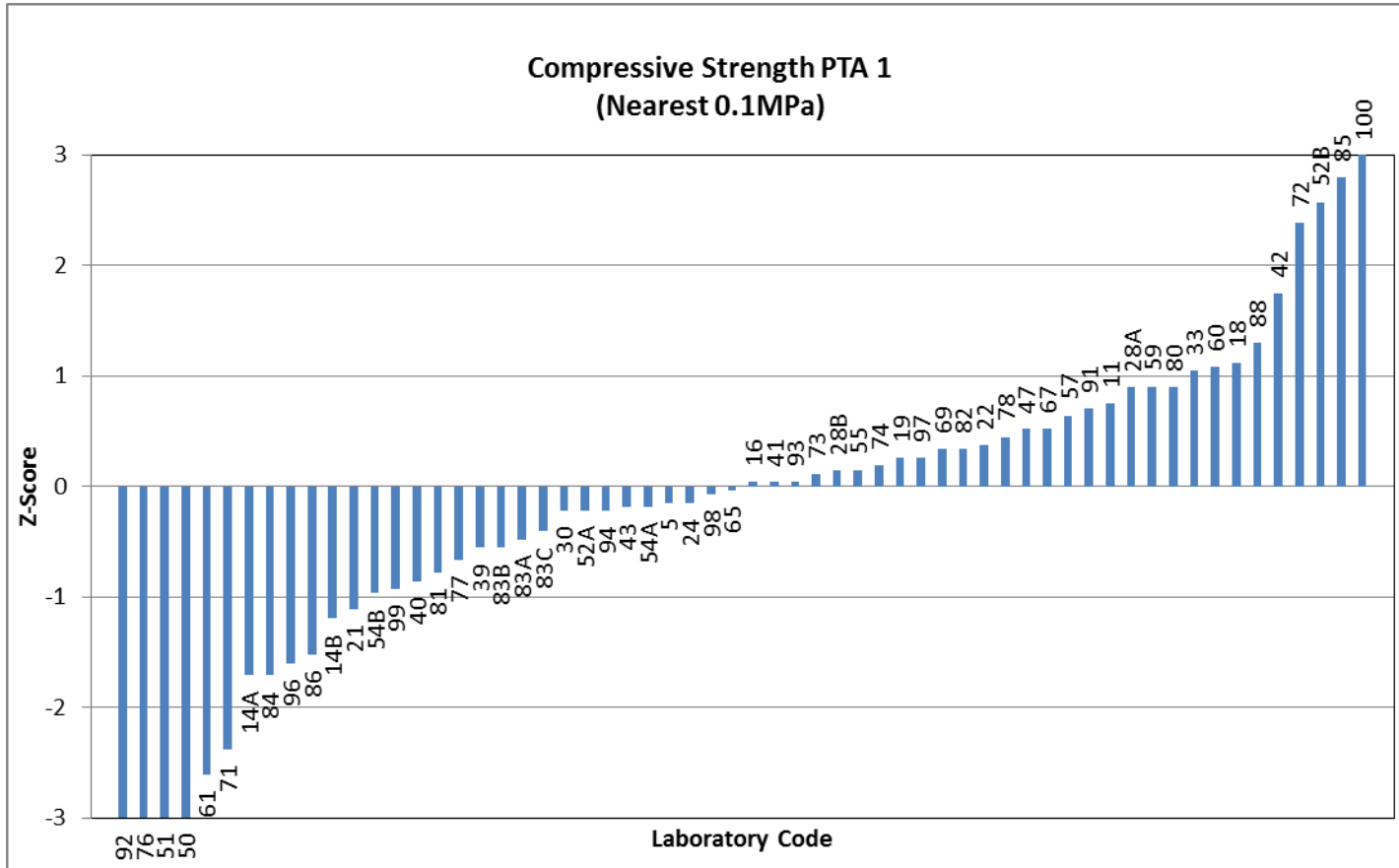


Lab Code	Mass/Volume PTA 2 (Nearest 1kg/m <sup>3</sup> )		Lab Code	Mass/Volume PTA 2 (Nearest 1kg/m <sup>3</sup> )	
	Result	Z-Score		Result	Z-Score
5	2436	1.22	61	2368	-3.95 §
11	2416	-0.30	65	2455	2.66 ?
14A	2416	-0.30	67	2420	0.00
14B	2408	-0.91	69	2422	0.15
16	2402	-1.37	71	2422	0.15
18	2420	0.00	72	2422	0.15
19	2383	-2.81 ?	73	2398	-1.67
21	2432	0.91	74	2400	-1.52
22	2438	1.37	76	2420	0.00
24	2403	-1.29	77	2414	-0.46
28A	2430	0.76	78	2530	8.36 §
28B	2420	0.00	80	2420	0.00
30	2413	-0.53	81	2420	0.00
33	2420	0.00	82	2429	0.68
39	2434	1.06	83A	2431	0.84
40	2417	-0.23	83B	2405	-1.14
41	2411	-0.68	83C	2434	1.06
42	2413	-0.53	84	2420	0.00
43	2414	-0.46	85	2452	2.43 ?
47	2427	0.53	86	2420	0.00
50	2395.25	-1.88	88	2423	0.23
51	2421	0.08	91	2433	0.99
52A	2455	2.66 ?	92	2437	1.29
52B	2420	0.00	93	2414	-0.46
54A	2426	0.46	94	2411	-0.68
54B	2427	0.53	96	2403	-1.29
55	2410	-0.76	97	2438	1.37
57	2426	0.46	98	2431	0.84
59	2400.0	-1.52	99	2424	0.30
60	2399	-1.60	100	2434	1.06



## A11

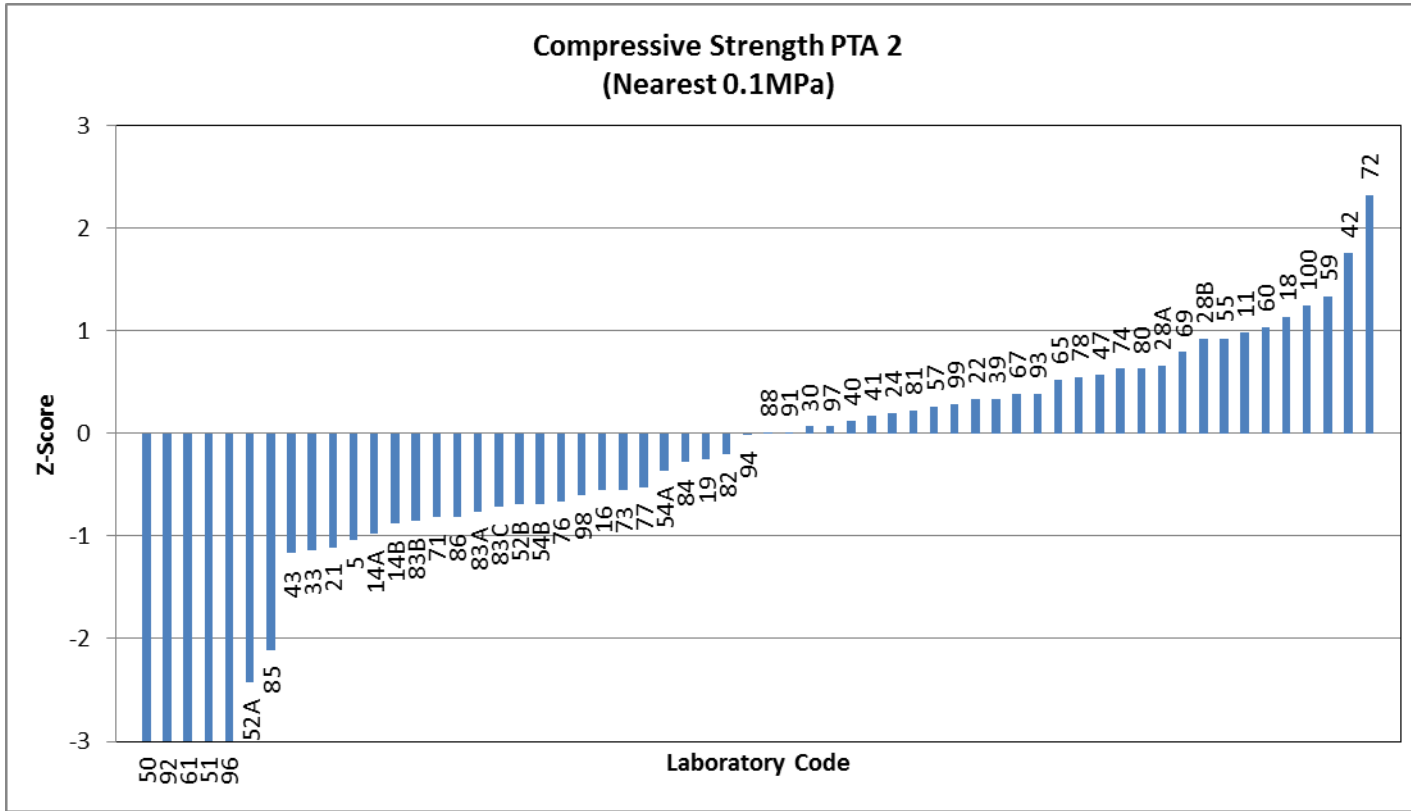
Lab Code	Compressive Strength PTA 1 (Nearest 0.1MPa)		Lab Code	Compressive Strength PTA 1 (Nearest 0.1MPa)	
	Result	Z-Score		Result	Z-Score
5	46.7	-0.15	61	40.1	-2.60 ?
11	49.1	0.74	65	47.0	-0.04
14A	42.5	-1.71	67	48.5	0.52
14B	43.9	-1.19	69	48.0	0.33
16	47.2	0.04	71	40.7	-2.38 ?
18	50.1	1.12	72	53.5	2.38 ?
19	47.8	0.26	73	47.4	0.11
21	44.1	-1.12	74	47.6	0.19
22	48.1	0.37	76	36.9	-3.80 §
24	46.7	-0.15	77	45.3	-0.67
28A	49.5	0.89	78	48.3	0.45
28B	47.5	0.15	80	49.5	0.89
30	46.5	-0.22	81	45.0	-0.78
33	49.9	1.04	82	48.0	0.33
39	45.6	-0.56	83A	45.8	-0.48
40	44.8	-0.86	83B	45.6	-0.56
41	47.2	0.04	83C	46.0	-0.41
42	51.8	1.75	84	42.5	-1.71
43	46.6	-0.19	85	54.6	2.79 ?
47	48.5	0.52	86	43.0	-1.53
50	38.32	-3.27 §	88	50.6	1.30
51	37.0	-3.76 §	91	49.0	0.71
52A	46.5	-0.22	92	35.5	-4.32 §
52B	54.0	2.57 ?	93	47.2	0.04
54A	46.6	-0.19	94	46.5	-0.22
54B	44.5	-0.97	96	42.8	-1.60
55	47.5	0.15	97	47.8	0.26
57	48.8	0.63	98	46.9	-0.07
59	49.5	0.89	99	44.6	-0.93
60	50.0	1.08	100	55.4	3.09 §



## A13

Lab Code	Compressive Strength PTA 2 (Nearest 0.1MPa)		Lab Code	Compressive Strength PTA 2 (Nearest 0.1MPa)	
	Result	Z-Score		Result	Z-Score
5	51.2	-1.03	61	42.9	-3.26 §
11	58.7	0.98	65	57.0	0.52
14A	51.4	-0.98	67	56.5	0.39
14B	51.8	-0.87	69	58.0	0.79
16	53.0	-0.55	71	52.0	-0.82
18	59.3	1.14	72	63.7	2.32 ?
19	54.1	-0.26	73	53.0	-0.55
21	50.9	-1.11	74	57.4	0.63
22	56.3	0.34	76	52.6	-0.66
24	55.8	0.20	77	53.1	-0.52
28A	57.5	0.66	78	57.1	0.55
28B	58.5	0.93	80	57.4	0.63
30	55.3	0.07	81	55.9	0.23
33	50.8	-1.14	82	54.3	-0.20
39	56.3	0.34	83A	52.2	-0.77
40	55.5	0.12	83B	51.9	-0.85
41	55.7	0.17	83C	52.4	-0.71
42	61.6	1.76	84	54.0	-0.28
43	50.7	-1.17	85	47.2	-2.11 ?
47	57.2	0.58	86	52.0	-0.82
50	36.45	-4.99 §	88	55.1	0.01
51	43.3	-3.15 §	91	55.1	0.01
52A	46.0	-2.43 ?	92	37.1	-4.82 §
52B	52.5	-0.68	93	56.5	0.39
54A	53.7	-0.36	94	55.0	-0.01
54B	52.5	-0.68	96	43.7	-3.05 §
55	58.5	0.93	97	55.3	0.07
57	56.0	0.26	98	52.8	-0.60
59	60.0	1.33	99	56.1	0.28
60	58.9	1.03	100	59.7	1.25





## A15

<b>Mass/Volume (Nearest 1kg/m<sup>3</sup>)</b>			
<b>PTA 1</b>		<b>PTA 2</b>	
No. of Results	60	No. of Results	60
Median	2461.5	Median	2420.0
Normalised IQR	17.2	Normalised IQR	13.2
Uncertainty of the Median	2.8	Uncertainty of the Median	2.1
Robust CV	0.7%	Robust CV	0.1%
Minimum	2170	Minimum	2368
Maximum	2559	Maximum	2530
Range	389	Range	162

<b>Compressive Strength (Nearest 0.1MPa)</b>			
<b>PTA 1</b>		<b>PTA 2</b>	
No. of Results	60	No. of Results	60
Median	47.10	Median	55.05
Normalised IQR	2.69	Normalised IQR	3.73
Uncertainty of the Median	0.43	Uncertainty of the Median	0.60
Robust CV	5.7%	Robust CV	6.8%
Minimum	35.5	Minimum	36.45
Maximum	55.4	Maximum	63.7
Range	19.9	Range	27.25

## A16

Lab Code	Failure Mode		Date of Receipt	Date of Tests
	PTA 1	PTA 2		
5	Satisfactory	Satisfactory	26/05/2017	1/06/2017
11	S	N	23/05/2017	1/06/2017
14A	Satisfactory	Satisfactory	26/05/2017	1/06/2017
14B	Satisfactory	Satisfactory	26/05/2017	1/06/2017
16	Normal	Normal	24/05/2017	1/06/2017
18	Normal	Normal	26/05/2017	1/06/2017
19	Shear	Shear	26/05/2017	1/06/2017
21	Sheer	Normal	27/05/2017	1/06/2017
22	Shear	Shear	26/05/2017	1/06/2017
24	Cone & Shear	Cone & Shear	24/05/2017	1/06/2017
28A	Normal	Normal	30/05/2017	1/06/2017
28B	Normal	Normal	30/05/2017	1/06/2017
30	N	Top Shear	25/05/2017	1/06/2017
33	TIPO 2 (Norma INVIA9 410-2013, ASTM C39/C39M-17A)	TIPO 2 (Norma INVIA9 410-2013, ASTM C39/C39M-17A)	30/05/2017	1/06/2017
39	Shear	Shear	25/05/2017	1/06/2017
40	Shear	Shear	1/06/2017	1/06/2017
41	Normal	Normal	24/05/2017	1/06/2017
42	Normal	Normal	25/05/2017	1/06/2017
43	4	4	1/06/2017	2/06/2017
47	Compression	Compression	22/05/2017	1/06/2017
50	Cone & Shear	Cone & Shear	30/05/2017	1/06/2017
51	Satisfactory Failure	Satisfactory Failure	6/06/2017	9/06/2017
52A	Shear	Shear	25/05/2017	1/06/2017
52B	Shear	Shear	25/05/2017	1/06/2017
54A	Normal	Normal	31/05/2017	1/06/2017
54B	Normal	Normal	31/05/2017	1/06/2017
55	N	N	22/05/2017	1/06/2017
57	Shear	Shear	24/05/2017	1/06/2017
59	Normal	Normal	23/05/2017	1/06/2017
60	Cone	Cone	29/05/2017	1/06/2017

## A17

Lab Code	Failure Mode		Date of Receipt	Date of Tests
	PTA 1	PTA 2		
61	Normal	Normal	26/05/2017	1/06/2017
65	Conical	Conical	24/05/2017	1/06/2017
67	Compressive Failure	Compressive Failure	25/05/2017	1/06/2017
69	Cone	Cone	24/05/2017	1/06/2017
71	Type 3	Type 3	26/05/2017	1/06/2017
72	Shear	Shear	30/05/2017	1/06/2017
73	Normal	Normal	24/05/2017	1/06/2017
74	Shear	Conical	24/05/2017	1/06/2017
76	Normal	Normal	25/05/2017	1/06/2017
77	Cone and Split	Cone and Split	26/05/2017	1/06/2017
78	Type 3	Type 3	7/06/2017	16/06/2017
80	N	N	23/05/2017	1/06/2017
81	Shear	Shear	23/05/2017	1/06/2017
82	#	#	24/05/2017	1/06/2017
83A	Vertical Splitting	Vertical Splitting	29/05/2017	1/06/2017
83B	Vertical Splitting	Vertical Splitting	29/05/2017	1/06/2017
83C	Vertical Splitting	Vertical Splitting	29/05/2017	1/06/2017
84	Compressive	Compressive	31/05/2017	1/06/2017
85	Normal	Normal	26/05/2017	1/06/2017
86	Conic- Shear	Shear	29/05/2017	1/06/2017
88	Normal	Normal	25/05/2017	1/06/2017
91	Type 3	Type 3	8/06/2017	9/06/2017
92	Type 3	Type 2	23/05/2017	1/06/2017
93	Normal	Normal	24/05/2017	1/06/2017
94	Normal	Normal	29/05/2017	1/06/2017
96	Type 2	Type 2	8/06/2017	9/06/2017
97	N	N	24/05/2017	1/06/2017
98	N	N	25/05/2017	1/06/2017
99	N	N	29/05/2017	1/06/2017
100	Compressive	Cap Shear	5/06/2017	5/06/2017

Notes:

“#” indicates no response was provided by the Laboratory.

## A18

Lab Code	Moisture Condition	Average Temperature Curing Tank	End Treatment	Method	Date of Tests
5	SSD	20°C	Sulphur Capping	BS EN 12390-3	1/06/2017
11	SSD	23°C	Ground	AS1012.9	1/06/2017
14A	SSD	20°C	Sulphur Capping	BS EN 12390-3; 2009	1/06/2017
14B	SSD	20°C	Sulphur Capping	BS EN 12390-3; 2009	1/06/2017
16	SSD	22°C	End Grinding	AS1012.9	1/06/2017
18	SSD	22°C	Ground	AS1012.9	1/06/2017
19	SSD	21.6°C	Rubber Cap	AS1012.9	1/06/2017
21	SSD	27°C	Rubber Cap	AS1012.9	1/06/2017
22	SSD	24°C	Rubber Cap	AS1012.9 (2014)	1/06/2017
24	SSD	27.1°C	Rubber Cap	AS1012.9	1/06/2017
28A	SSD	26.5	Rubber Cap	AS1012.9	1/06/2017
28B	SSD	26.5	Rubber Cap	AS1012.9	1/06/2017
30	SSD	23°C	Rubber Cap	AS1012.9	1/06/2017
33	Húmedo, sin doño da los cilindros	20.07°C	Almacenamiento temporal por quinoa (15) días	Norma INVIA9 410-2013, ASTM C39/C39M-17A	1/06/2017
39	SSD	22.4°C	Rubber	AS1012.9	1/06/2017
40	SSD	23°C	Rubber Cap	1012.9	1/06/2017
41	SSD	23°C	Sulphur	AS1012.9	1/06/2017
42	SSD	23°C	Rubber Cap	AS1012.9	1/06/2017
43	SSD	Do not apply	Neoprene	NTC 673-2010/ ASTM C39/C39M-16	2/06/2017
47	SSD	26-27°C	Rubber	AS1012.9 & 12.1	1/06/2017
50	SSD	27°C	#	ASTM C-39	1/06/2017
51	SSD	27.9°C	Grinding	MS26:Part 2: 1991	9/06/2017
52A	SSD	27	Sulfur Cap	AS1012 Sect 9, Sect 12	1/06/2017
52B	SSD	27	Sulfur	AS1012 Sect 9, Sect 12	1/06/2017
54A	SSD	28	Grind	AS1012	1/06/2017
54B	SSD	28	Grind	AS1012	1/06/2017
55	SSD	24	Ground	AS1012.9	1/06/2017
57	SSD	26	Rubber Cap	AS1012.12.1 & 9	1/06/2017
59	SSD	28°C	End Ground	AS1012	1/06/2017
60	SSD	#	#	Rubber Cap/Neo Prene	1/06/2017

## Notes:

"#" indicates no response was provided by the Laboratory.

## A19

Lab Code	Moisture Condition	Average Temperature Curing Tank	End Treatment	Method	Date of Tests
61	SSD	#	Rubber Capping	AS1012.9	1/06/2017
65	SSD	21°C	Rubber Cap	NZS 3112.2	1/06/2017
67	SSD	23°C	Moulded Rubber Capped	AS1012	1/06/2017
69	SSD	27°C	Grind	AS1012.9 & AS1012.12.1	1/06/2017
71	SSD	28.9°C	Sulphur Capping	BS 1881/ ASTM C39	1/06/2017
72	SSD	29°C	Rubber Capping	ASTM C39	1/06/2017
73	SSD	26.7°C	Rubber	AS1012.8.1	1/06/2017
74	SSD	25°C	Rubber Cap	AS1012.9	1/06/2017
76	SSD	24°C	Sulphur Capping	AS1012	1/06/2017
77	SSD	22.2	Restrained Rubber	AS1012.8.1/.9/.12.1	1/06/2017
78	SSD	19.5°C	Sulphur Capping	ASTM C39M-17a	16/06/2017
80	SSD	26.5°	Ground	AS1012	1/06/2017
81	SSD	27.0°C	Rubber Cap	AS1012	1/06/2017
82	SSD	22.0°C	Rubber Cap	NZS 3112: Part 2, 1986	1/06/2017
83A	SSD	23°C	Grinding	AS1012.9	1/06/2017
83B	SSD	23°C	Grinding	AS1012.9	1/06/2017
83C	SSD	23°C	Grinding	AS1012.9	1/06/2017
84	SSD	22.6	End Grind	AS1012.9	1/06/2017
85	SSD	27.3°C	Rubber	AS1012.9	1/06/2017
86	SSD	23°C	Rubber	AS1012.9	1/06/2017
88	SSD	23°C	Rubber Cap	AS1012.9	1/06/2017
91	SSD	25°C	Rubber	NTC 673 (2010-02-17)	9/06/2017
92	SSD	22.6°C	Sulphur Capping	ASTM C39M-17a	1/06/2017
93	SSD	23°C	Ground	AS1012.9	1/06/2017
94	SSD	23°C	Rubber Capped	AS1012	1/06/2017
96	SSD	23°C	#	NTC 673-2010	9/06/2017
97	SSD	26°C	#	AS1012.9 & AS1012.12.1	1/06/2017
98	SSD	22-24°C	Sulphur Capping	AS1012.9 - Avery Crushing Machine	1/06/2017
99	SSD	#	Rubber Capping (75 Duro)	AS1012.9.6.3	1/06/2017
100	SSD	N/A	Rubber Capping	AS1012.9/AS1012.12.2	5/06/2017

## Notes:

"#" indicates no response was provided by the Laboratory.

# **APPENDIX B**

## **Homogeneity Testing**

**Homogeneity Testing: PTA 1**

Concrete Round 22 Homogeneity Results									
PTA 1									
Sample Number	Date Sampled	Date Tested	Height (mm)	Average Diameter (mm)	Mass per Unit Volume (kg/m <sup>3</sup> )	Compressive Strength (MPa)	Age of Specimen (Days)	Capping Method	Condition of Specimen
75	18/04/2017 / 10:45	1/06/2017	200	100.4	2440	46	44	Rubber	SSD
31	18/04/2017 / 10:45	1/06/2017	200	100.4	2460	47.5	44	Rubber	SSD
62	18/04/2017 / 10:45	1/06/2017	201	100.4	2440	44.5	44	Rubber	SSD
64	18/04/2017 / 10:45	1/06/2017	199	100.2	2440	46.5	44	Rubber	SSD
17	18/04/2017 / 10:45	1/06/2017	200	100	2460	45.5	44	Rubber	SSD
66	18/04/2017 / 10:45	1/06/2017	200	100.4	2440	46	44	Rubber	SSD
89	18/04/2017 / 10:45	1/06/2017	199	100	2460	46	44	Rubber	SSD
79	18/04/2017 / 10:45	1/06/2017	201	100	2460	45.5	44	Rubber	SSD
3	18/04/2017 / 10:45	1/06/2017	201	100.4	2440	43	44	Rubber	SSD
8	18/04/2017 / 10:45	1/06/2017	199	100	2460	46	44	Rubber	SSD
<b>Mean</b>			200	100.22	2450	45.65			
<b>Standard Deviation</b>			0.82	0.20	10.54	1.20			
<b>Coefficient of Variation</b>			0.41%	0.20%	0.43%	2.64%			
<b>Lowest Value</b>			199	100	2440	43			
<b>Highest Value</b>			201	100.4	2460	47.5			



**Homogeneity Testing PTA 2**

Concrete Round 22 Homogeneity Results									
PTA 2									
Sample Number	Date Sampled	Date Tested	Height (mm)	Average Diameter (mm)	Mass per Unit Volume (kg/m <sup>3</sup> )	Compressive Strength (MPa)	Age of Specimen (Days)	Capping Method	Condition of Specimen
75	19/04/2017 / 11:10	1/06/2017	199	100.2	2420	54	43	Rubber	SSD
31	19/04/2017 / 11:10	1/06/2017	199	100.2	2420	53.5	43	Rubber	SSD
62	19/04/2017 / 11:10	1/06/2017	199	100.2	2420	55.5	43	Rubber	SSD
64	19/04/2017 / 11:10	1/06/2017	199	100.2	2420	53	43	Rubber	SSD
17	19/04/2017 / 11:10	1/06/2017	199	100	2440	56.5	43	Rubber	SSD
66	19/04/2017 / 11:10	1/06/2017	199	100	2420	55	43	Rubber	SSD
89	19/04/2017 / 11:10	1/06/2017	199	100.2	2420	55	43	Rubber	SSD
79	19/04/2017 / 11:10	1/06/2017	200	100	2420	58	43	Rubber	SSD
3	19/04/2017 / 11:10	1/06/2017	200	100.4	2400	57	43	Rubber	SSD
8	19/04/2017 / 11:10	1/06/2017	199	100.2	2440	54.5	43	Rubber	SSD
<b>Mean</b>			199.2	100.16	2422	55.2			
<b>Standard Deviation</b>			0.42	0.13	11.35	1.58			
<b>Coefficient of Variation</b>			0.21%	0.13%	0.47%	2.87%			
<b>Lowest Value</b>			199	100	2400	53			
<b>Highest Value</b>			200	100.4	2440	58			

# APPENDIX C

## Documentation

Instructions to Participants.....	C1
Results Sheet.....	C3



PROFICIENCY TESTING AUSTRALIA  
Proficiency Testing Program  
Concrete Round 22

**INSTRUCTIONS TO PARTICIPANTS**

**PLEASE NOTE CYLINDERS ARE TO BE TESTED ON THE 1<sup>st</sup> June 2017**

**If you receive your cylinders before this date place them in the curing tank and refer to step 5 and 6 of the instructions.**

Please read instructions carefully **BEFORE** commencing testing.

**To ensure that the results of this program can be analysed properly, participants are asked to carefully note the following:**

1. Two concrete cylinders (nominally 100 mm diameter x 200 mm length) have been supplied to each laboratory. The cylinders are marked PTA 1 and PTA 2.
2. Participants are to treat the proficiency testing samples as they would a routine sample tested in the laboratory.
3. The following determinations are to be performed on each sample:

Height - to nearest 1 mm  
Diameter - to nearest 0.2 mm  
Weight - to nearest 1g  
Mass per unit Volume - to the nearest 1 kg/m<sup>3</sup>  
Maximum Sustained Load Unit - to nearest 1 kN  
Compressive Strength - to the nearest 0.1 MPa  
Type of Fracture

The results for all determinations are to be recorded on the results sheet to the accuracy and reporting basis indicated where possible. **Please ensure you check your rounding details.**

4. The tests are based on AS1012; however other methods may be used. Note a higher level of accuracy is requested for specific tests to allow for statistical comparison.
5. Remove the newspaper and plastic bag, and record the moisture condition on the results sheet. Also record if there has been any damage caused to the cylinders.
6. Place the cylinders in the curing tank within 30 minutes of unwrapping. Ensure that the cylinders remain totally immersed in water until compression tested. Each day record on the results sheet the temperature (<sup>0</sup>C) of the curing tank water until tested.
7. Remove and test the cylinders marked PTA 1 and PTA 2 on **1<sup>st</sup> June 2017**
8. Wipe all the excess water and any loose accumulation of grit and lime, such that the cylinders have a clean but damp surface only.
9. Immediately weigh the cylinder on a balance to the nearest 1 gram.

**10.** Measure the height of the cylinders to the nearest 1 mm. Measure the diameter in the middle of the cylinder to the nearest 0.2 mm (Record as Result 1). Repeat the process measuring from a 90° rotation (Record as Result 2). Do not measure on the mould joint as marked on the cylinder.

**11.** Treat the ends of each test cylinder by sulphur capping, rubber capping or end grinding.

**12.** After end treatment allow the sulphur caps to cure for 1 hour prior to testing. Moulded rubber capped and ground cylinders may be tested immediately. Test the cylinders for compressive strength to AS1012 or other methods.

The following steps shall be observed:

12.1 Wipe clean the upper and lower platten of the testing machine with a hand broom/a cloth.

12.2 Wipe both ends of the cylinder capping to remove excess water.

12.3 Place the cylinder in the testing machine.

12.4 Set the load pacing control unit at 20 MPa ± 2 MPa (157 kN/minute).

12.5 Start the compression machine and increase the load at the rate described in AS1012 until the cylinder fails. Record the maximum load on the results sheet.

12.6 Record the type of failure.

12.7 Record the type of end treatment.

**13.** Calculate the Mass per unit Volume to the nearest 1 kg/m<sup>3</sup>.

**14.** Calculate the Compressive Strength to the nearest 0.1 MPa.

**15.** For this program your laboratory has been allocated the code number shown on the results sheet. All reference to your laboratory in reports associated with this program will be with this code number, thus ensuring confidentiality of results.

**16.** All laboratories must return the results sheet no later than **Friday 16<sup>th</sup> June 2017** to:

**Sheren To**  
**Proficiency Testing Australia**  
**Fax: 02 9743 6664**  
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PROFICIENCY TESTING AUSTRALIA  
**Concrete 22 - Proficiency Testing Program**  
**Results Sheet**

TEST DATE: Thursday 1<sup>st</sup> JuneLab Code: 

**NOTE:** When entering results, please ensure that the measurement recorded corresponds to the cylinder PTA 1 or PTA 2.

TEST (report to)	PTA 1		PTA 2	
Height (nearest 1 mm)				
Diameter (nearest 0.2 mm)	Result 1	Result 2	Result 1	Result 2
Weight (nearest 1g)				
Mass/Volume (nearest 1 kg/m <sup>3</sup> )				
Maximum Sustained Load Unit (nearest 1 kN)				
Compressive Strength (nearest 0.1 MPa)				
Failure Mode				

**Please ensure to check rounding details.**

Date of receipt \_\_\_\_\_

Moisture condition on receipt (SSD or dry): \_\_\_\_\_

Average temperature of the curing tank:

Details of end treatment \_\_\_\_\_

Method: \_\_\_\_\_

Date of tests - PTA 1 &amp; PTA 2: \_\_\_\_\_

Signature: \_\_\_\_\_

Return no later than **16<sup>th</sup> June 2017** to:**Sheren To****Proficiency Testing Australia****Phone: 02 9736 8397****Fax: 02 9743 6664****Email: [sheren.to@pta.asn.au](mailto:sheren.to@pta.asn.au)**

- *End of Report* -