

**Report No. 1078**

# **Concrete Proficiency Testing Program**

**Round 23**

**May 2018**

## **Acknowledgments**

PTA wishes to gratefully acknowledge the technical assistance provided for this program by Mr M McCarthy from Soils Engineering Services, Brisbane, QLD. Also our thanks go to Mr D Sankey from Soils Engineering Services, Brisbane, QLD for the supply of the samples.

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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-third round of an ongoing series of programs.

The program was conducted in March 2018 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 Dr E Cincu and the Technical Adviser was Mr M McCarthy from Soils Engineering Services, Brisbane, QLD. This report was authorised by Mrs F Watton, PTA Quality Manager.

## 2. FEATURES OF THE PROGRAM

- (a) Participants were provided with two concrete cylinders labelled PTA 1 and PTA 2.
- (b) A total of 85 laboratories received samples, comprising:
  - 73 Australian participants; and
  - 12 overseas participants, including:
    - Botswana (1);
    - Colombia (1);
    - India (1);
    - Malaysia (1);
    - New Zealand (2);
    - Papua New Guinea (3);
    - Qatar (1); and
    - South Korea (2)

Of these 85 laboratories, one was 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 eight 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.
- (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.
- (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 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 (if applicable).

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 1 mm)	84	200.0	193	202
Height - PTA 2 (Nearest 1 mm)	84	199.0	193	201
Diameter PTA 1 (Nearest 0.2 mm)	84	100.00	99.8	101.6
Diameter PTA 2 (Nearest 0.2 mm)	84	100.00	99.5	101.6
Weight PTA 1 (Nearest 1 g)	83	3733.0	3227	3831
Weight PTA 2 (Nearest 1 g)	83	3776.0	3671	3825
Maximum Sustained Load Unit PTA 1 (Nearest 1 kN)	84	420.0	284	560
Maximum Sustained Load Unit PTA 2 (Nearest 1 kN)	84	468.5	325	607

**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 1 kg/m <sup>3</sup> )	83	2372.0	11.5	0.5%
Mass/Volume PTA 2 (Nearest 1 kg/m <sup>3</sup> )	83	2419.0	15.2	0.6%
Compressive Strength PTA 1 (Nearest 0.1 MPa)	84	53.40	3.48	6.5%
Compressive Strength PTA 2 (Nearest 0.1 MPa)	84	59.50	3.30	5.5%

## **5. PTA AND TECHNICAL ADVISER'S COMMENTS**

A total of 85 laboratories (73 Australian and 12 overseas) participated in this round. Of these, one laboratory did not submit results in time to be included in the final report.

### **Overall performance against prior expectations**

Altogether, 19 outliers were detected from the 334 results analysed, resulting in 5.7% of results classified as outliers. The number of outliers is similar to the previous rounds, as shown in Table E. Overall, a satisfactory performance was achieved in this round, with a low percentage of outliers.

All laboratories with outliers (“§”) or an absolute z-score between 2.0 and 3.0 (“?”) are encouraged to review their procedures.

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

Table B gives a comparison of the robust CVs for tests common to previous programs. The CV values in Concrete round 23 are similar to those from previous rounds and are within the expected variability.

### **Variations between laboratories**

The variation of results between participants has been assessed and found to be satisfactory due to the low number of outliers.

A number of laboratories received their samples late and could not perform the testing on the requested date (see “Date of Tests” information supplied in Appendix A). This may have affected 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.

## Variations between test methods and procedures

The majority of participants performed the required testing under AS 1012.9 and AS 1012.12. Other test methods used include ASTM C39-16b, ASTM C39M-18, BOS 27, INV E-410, KS F 2405, MS 26 Part 2, NZS 3112.2 and NZS 3112.3.

## Possible sources of error and suggestions for improvement

Possible sources of error that may affect the outcome of the proficiency testing program include, but are not limited to:

- the condition of concrete specimens (damage during dispatch, late testing)
- interpretation of test methods and procedures
- calibration of laboratory instruments
- incorrect calculations
- mistakes during recording the results on the 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

Participants could also perform internal proficiency tests under senior supervision to try to isolate the anomalies if any are found.

## Conclusion

Overall, participants in Concrete round 23 have done an exceptional job and the consistency between results would support this.

**TABLE B: COMPARISON OF PREVIOUS ROUND CVS**

Test	Round 20	Round 21	Round 22	Round 23
Mass/Volume PTA 1 (Nearest 1 kg/m <sup>3</sup> )	0.5%	0.5%	0.7%	0.5%
Mass/Volume PTA 2 (Nearest 1 kg/m <sup>3</sup> )	0.7%	0.5%	0.1%	0.6%
Compressive Strength PTA 1 (Nearest 0.1 MPa)	4.2%	4.8%	5.7%	6.5%
Compressive Strength PTA 2 (Nearest 0.1 MPa)	4.4%	4.7%	6.8%	5.5%



### 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.

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.

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

### Analysis of Results by Method Groups

Further analysis of results by method group 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.

Methods AS 1012.9 and AS 1012.12 were both required to calculate a final Mass Per Unit Volume (MPUV) and AS 1012.9 was required to determine the Compressive Strength. Table C below presents the Median, Uncertainty of the Median and Robust CV of the results obtained by the respective methods.

**TABLE C: SUMMARY OF GROUP ANALYSIS**

<b>Test</b>	<b>Method</b>	<b>Sample</b>	<b>Number of Results</b>	<b>Median</b>	<b>Uncertainty of the Median</b>	<b>Robust CV</b>
Mass/Volume (Nearest 1 kg/m <sup>3</sup> )	AS 1012.9 and AS 1012.12	PTA 1	17	2367.0	2.5	0.3%
		PTA 2	17	2419.0	4.5	0.6%
Compressive Strength (Nearest 0.1 MPa)	AS 1012.9	PTA 1	55	53.00	0.51	5.7%
		PTA 2	55	59.70	0.56	5.5%

## 6. OUTLIER RESULTS

Laboratories reporting outlier results are listed in the following table:

**TABLE D: SUMMARY OF STATISTICAL OUTLIERS**

Test	Laboratory Code No.
Mass/Volume PTA 1 (Nearest 1 kg/m <sup>3</sup> )	10, 39, 44, 47
Mass/Volume PTA 2 (Nearest 1 kg/m <sup>3</sup> )	10, 39, 44, 69, 90
Compressive Strength PTA 1 (Nearest 0.1 MPa)	12, 38, 39, 48, 53A
Compressive Strength PTA 2 (Nearest 0.1 MPa)	34, 39, 48, 90, 97

**TABLE E: COMPARISON OF PREVIOUS ROUNDS  
PERCENTAGE OF OUTLIERS**

Test	Round 20	Round 21	Round 22	Round 23
Mass/Volume PTA 1 (Nearest 1 kg/m <sup>3</sup> )	11.5%	5.9%	5%	4.8%
Mass/Volume PTA 2 (Nearest 1 kg/m <sup>3</sup> )	9.6%	3.9%	3.3%	6%
Compressive Strength PTA 1 (Nearest 0.1 MPa)	5.7%	7.8%	8.3%	5.9%
Compressive Strength PTA 2 (Nearest 0.1 MPa)	9.4%	5.9%	8.3%	5.9%

## 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 for testing concrete. Compressive strength tests - Concrete, mortar and grout specimens*
- [3] AS 1012.8.1:2014 *Methods of testing concrete. Method for making and curing concrete - Compression and indirect tensile test specimens*

- [4] AS 1012.12.1:1998 (R2014) *Methods of testing concrete. Determination of mass per unit volume of hardened concrete - Rapid measuring method*
- [5] AS 1012.12.2:1998 (R2014) *Methods of testing concrete. Determination of mass per unit volume of hardened concrete - Water displacement method*
- [6] ASTM C39/C39-16b *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*
- [7] ASTM C39/C39M-18 *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*
- [8] BOS 27:2000 *Concrete Masonry Units*
- [9] INV E-410:2013 *Resistencia a la compresión de cilindros de concreto (Compressive Strength of Cylindrical Concrete)*
- [10] KS F 2405:2010 *Standard test method for compressive strength of concrete*
- [11] MS 26 Part 2:1991 *Methods Of Testing Concrete Part 2: Methods of Testing Hardened Concrete (First Revision)*
- [12] NZS 3112.2:1986 A2 *Methods of test for concrete - Tests relating to the determination of strength of concrete: Amendment 2*
- [13] NZS 3112.3:1986 A1 *Methods of test for concrete - Tests on hardened concrete other than for strength: Amendment 1*

# APPENDIX A

## Results and Data Analysis

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

Lab Code	Height (Nearest 1 mm)	
	PTA 1	PTA2
1	201	201
2	200	198
4	200	200
5	201	198
6	201	201
7	200	198
8	200	198
9	200.0	199.0
10	202	201
12	200	199
13	201	199
14	200	200
15	200	197
16	200	200
18	200	198
19	198	197
20	200	200
22	201	201
23	193	193
24	199	197
25	200	199
26	200	200
27	199	199
29	200	199
30	198	196
32	200	199
33	200	200
34	201	200
35	200	199
36	201.0	199.00
37	200	200
38	197	197
39	200	200
40	196	197
42	200	198
43	200	199
44	199.0	200.0
45	201	201
46	198	197
47	201	199
48	201	200
50	200	199

Lab Code	Height (Nearest 1 mm)	
	PTA 1	PTA2
51	200	198
52	200	199
53A	200	200
54	200	198
55	200	199
56	199	199
58	201	199
61	200	199
62	199	198
64	200	198
65	201	200
66	199	199
67	200	198
68	201	199
69	201	201
70	200	198
71	200.0	199.0
72	200	198
74	200	200
76	198	200
77	200	199
79	200	199
80	202	199
81	200	200
82	200.0	198.0
83	201	200
84	200	200
85	200	200
86	200	199
88	200	198
89	199	198
90	200	201
91	200	197
92	195	196
93	201	199
94	198	196
95	200	200
96	201	199
97	200	200
98	200	198
99	200	199
100	196	196

Lab Code	Diameter PTA 1 (Nearest 0.2 mm)			Lab Code	Diameter PTA 1 (Nearest 0.2 mm)		
	Result 1	Result 2	Average		Result 1	Result 2	Average
1	100.0	#	100.0	51	100.2	#	100.2
2	100.0	#	100.0	52	99.8	100.5	100.2
4	100	#	100	53A	100.0	#	100.0
5	100.2	#	100.2	54	99.8	100.2	100.0
6	100.2	#	100.2	55	100.4	#	100.4
7	100.0	#	100.0	56	100.4	100.2	100.3
8	99.9	#	99.9	58	100.2	#	100.2
9	100.2	#	100.2	61	100.2	99.8	100.0
10	100.2	#	100.2	62	100.0	100.0	100.0
12	100.2	#	100.2	64	99.6	100.4	100.0
13	100.2	#	100.2	65	100.0	#	100.0
14	99.8	#	99.8	66	100.0	100.0	100.0
15	100.2	#	100.2	67	100.14	100.00	100.07
16	100.2	#	100.2	68	100.0	#	100.0
18	100.0	#	100.0	69	100.4	100.4	100.4
19	100.0	100.0	100.0	70	100.6	#	100.6
20	100.0	#	100.0	71	100.0	#	100.0
22	99.80	#	99.80	72	100.0	#	100.0
23	99.8	#	99.8	74	100.0	#	100.0
24	100.0	#	100.0	76	100.0	100.4	100.2
25	100.0	100.4	100.2	77	100.0	#	100.0
26	100	#	100	79	100.2	#	100.2
27	100.2	#	100.2	80	100.0	#	100.0
29	100.0	#	100.0	81	100.0	#	100.0
30	100.0	#	100.0	82	99.8	100.2	100.0
32	100.0	100.0	100.0	83	100.2	#	100.2
33	99.8	100.0	99.9	84	100.2	#	100.2
34	100.4	100.4	100.4	85	100.2	#	100.2
35	100.0	100.2	100.1	86	100.0	#	100.0
36	100.4	100.0	100.2	88	100.2	#	100.2
37	100.0	100.0	100.0	89	100.2	100.2	100.2
38	100.0	#	100.0	90	100	#	100
39	101.6	#	101.6	91	100.2	99.8	100.0
40	100.0	#	100.0	92	100.0	#	100.0
42	100.2	100.4	100.3	93	99.8	99.8	99.8
43	100.0	#	100.0	94	100.2	#	100.2
44	100.0	#	100.0	95	100.2	#	100.2
45	100.0	#	100.0	96	100.2	#	100.2
46	100.2	#	100.2	97	100.0	#	100.0
47	100	#	100	98	100.0	#	100.0
48	100	#	100	99	100	100.2	100.1
50	100.0	100.6	100.3	100	100.4	#	100.4

Note: “#” indicates no response was provided by the laboratory

Lab Code	Diameter PTA 2 (Nearest 0.2 mm)			Lab Code	Diameter PTA 2 (Nearest 0.2 mm)		
	Result 1	Result 2	Average		Result 1	Result 2	Average
1	100.0	#	100.0	51	100.2	#	100.2
2	100.2	#	100.2	52	99.7	100.2	100
4	100.0	#	100.0	53A	100.0	#	100.0
5	100.2	#	100.2	54	100.0	100.2	100.1
6	100.2	#	100.2	55	100.2	#	100.2
7	100.0	#	100.0	56	99.8	100.0	99.9
8	99.9	#	99.9	58	100.1	#	100.1
9	100.2	#	100.2	61	99.6	100.4	100.0
10	100.0	#	100.0	62	99.8	99.8	99.8
12	100.0	#	100.0	64	100.4	99.6	100.0
13	100.2	#	100.2	65	100.0	#	100.0
14	99.8	#	99.8	66	99.8	100.2	100.0
15	100.0	#	100.0	67	99.30	99.70	99.5
16	100.4	#	100.4	68	100.1	#	100.1
18	100.0	#	100.0	69	100.6	100.6	100.6
19	100.0	100.0	100.0	70	100.0	#	100.0
20	100.0	#	100.0	71	100.0	#	100.0
22	100.00	#	100.00	72	100.0	#	100.0
23	99.8	#	99.8	74	100.0	#	100.0
24	100.0	#	100.0	76	100.0	100.2	100.1
25	100.0	100.2	100.1	77	100.0	#	100.0
26	100.2	#	100.2	79	100.0	#	100.0
27	100.0	#	100.0	80	99.8	#	99.8
29	100.0	#	100.0	81	100.2	#	100.2
30	100.2	#	100.2	82	100.0	100.2	100.1
32	99.8	100.0	99.9	83	100.2	#	100.2
33	100.21	100.21	100.21	84	100.2	#	100.2
34	100.0	100.2	100.1	85	100.2	#	100.2
35	100.0	100.2	100.1	86	100.0	#	100.0
36	100.35	100.00	100.20	88	100.4	#	100.4
37	100.0	100.0	100.0	89	100.2	100.4	100.3
38	100.0	#	100.0	90	100.8	#	100.8
39	101.6	#	101.6	91	100.0	100.0	100.0
40	100.0	#	100.0	92	100.4	#	100.4
42	100.2	100.2	100.2	93	99.8	100.0	99.9
43	100.0	#	100.0	94	100.2	#	100.2
44	100.2	#	100.2	95	99.8	#	99.8
45	99.9	#	99.9	96	100.4	#	100.4
46	100.4	#	100.4	97	100.0	#	100.0
47	99.9	#	99.9	98	99.8	#	99.8
48	100	#	100	99	100	100.4	100.2
50	100.0	100.4	100.2	100	100.2	#	100.2

Note: “#” indicates no response was provided by the laboratory

Lab Code	Weight (Nearest 1 g)	
	PTA 1	PTA 2
1	3721	3809
2	3708	3756
4	3736	3808
5	3719	3778
6	3728	3825
7	3760	3767
8	3741	3760
9	3727	3756
10	3831	3731
12	3750	3779
13	3744	3760
14	3750	3768
15	3733	3798
16	3738	3818
18	3699	3784
19	3703	3766
20	3724	3768
22	3699	3779
23	3614	3671
24	3698	3742
25	3747.0	3783
26	3721	3792.3
27	3728	3780
29	3750	3757
30	3712	3745
32	3720	3785
33	3741	3752
34	3733	3807
35	3746	3775
36	3738	3786
37	3722	3811
38	3674	3762
39	3751	3780
40	3662	3767
42	3743	3759
43	3742	3784
44	3821	3734
45	3737.0	3765.3
46	3698	3760
47	3227	3785
48	3739	3762
50	3729	3785

Lab Code	Weight (Nearest 1 g)	
	PTA 1	PTA 2
51	3733	3768
52	3734	3775
53A	3722	3777
54	3726	3763
55	3746	3776
56	3740	3806
58	3762	3773
61	3742	3796
62	3746	3800
64	3732	3782
65	3742	3773
66	3704	3795
67	3726	3762
68	3737	3774
69	3724	3785
70	3731	3794
71	3735	3778
72	3722	3760
74	3742	3776
77	3725	3734
79	3724	3792
80	3733	3769
81	3731	3784
82	3735	3785
83	3734	3816
84	3733	3787
85	3763	3803
86	3733	3808
88	3746	3798
89	3703	3762
90	3722	3770
91	3739	3748
92	3638	3757
93	3747	3763
94	3709	3736
95	3732.7	3812.6
96	3710	3792
97	3728	3783
98	3732	3760
99	3749.7	3795.0
100	3669	3727



Lab Code	Maximum Sustained Load Unit (Nearest 1 kN)	
	PTA 1	PTA 2
1	432	467
2	444	454
4	413	487
5	417	469
6	387.0	405.0
7	392	462
8	453	474
9	446	462
10	355	406
12	288	409
13	445	460
14	374	418
15	393	485
16	448	472
18	401	450
19	382	449
20	442.0	488.9
22	431	464
23	432	486
24	446	491
25	390.0	445.0
26	382	441
27	421	500
29	406	462
30	428	449
32	421	457.0
33	406	422
34	407	382
35	448	407
36	416.3	453.5
37	435	453
38	311	395
39	560	607
40	416	464
42	412	478
43	439	465
44	452	431
45	430	474
46	432	490
47	410	472
48	284	372
50	400	472

Lab Code	Maximum Sustained Load Unit (Nearest 1 kN)	
	PTA 1	PTA 2
51	423	475
52	439	466
53A	336	393
54	396	464
55	441	471
56	453	484
58	432.0	485
61	408	509
62	432	489
64	436	503
65	403.6	471.0
66	436	511
67	422	489
68	425	440
69	353	474
70	426	488
71	419	456
72	369	397
74	397	463
76	416.1	483.7
77	405	478
79	429	449
80	422	485
81	410	449
82	439	513
83	408	485
84	391	485
85	418	476
86	438	478
88	401	468
89	445	466
90	347	325
91	437	481
92	418	474
93	441	480
94	449	485
95	402.0	439.0
96	432	488
97	387	366
98	454	527
99	424.9	481.2
100	380	415

### Summary Statistics

Test	No. of Results	Median	Minimum	Maximum
Height - PTA 1 (Nearest 1 mm)	84	200.0	193	202
Height - PTA 2 (Nearest 1 mm)	84	199.0	193	201
Diameter PTA 1 (Nearest 0.2 mm)	84	100.00	99.8	101.6
Diameter PTA 2 (Nearest 0.2 mm)	84	100.00	99.5	101.6
Weight PTA 1 (Nearest 1 g)	83	3733.0	3227	3831
Weight PTA 2 (Nearest 1 g)	83	3776.0	3671	3825
Maximum Sustained Load Unit PTA 1 (Nearest 1 kN)	84	420.0	284	560
Maximum Sustained Load Unit PTA 2 (Nearest 1 kN)	84	468.5	325	607

Notes that apply to the following tables:

"#" indicates no response was provided by the laboratory

"?" indicates an absolute z-score greater than 2.0 but less than 3.0,  
i.e.  $2.0 < |z\text{-score}| < 3.0$

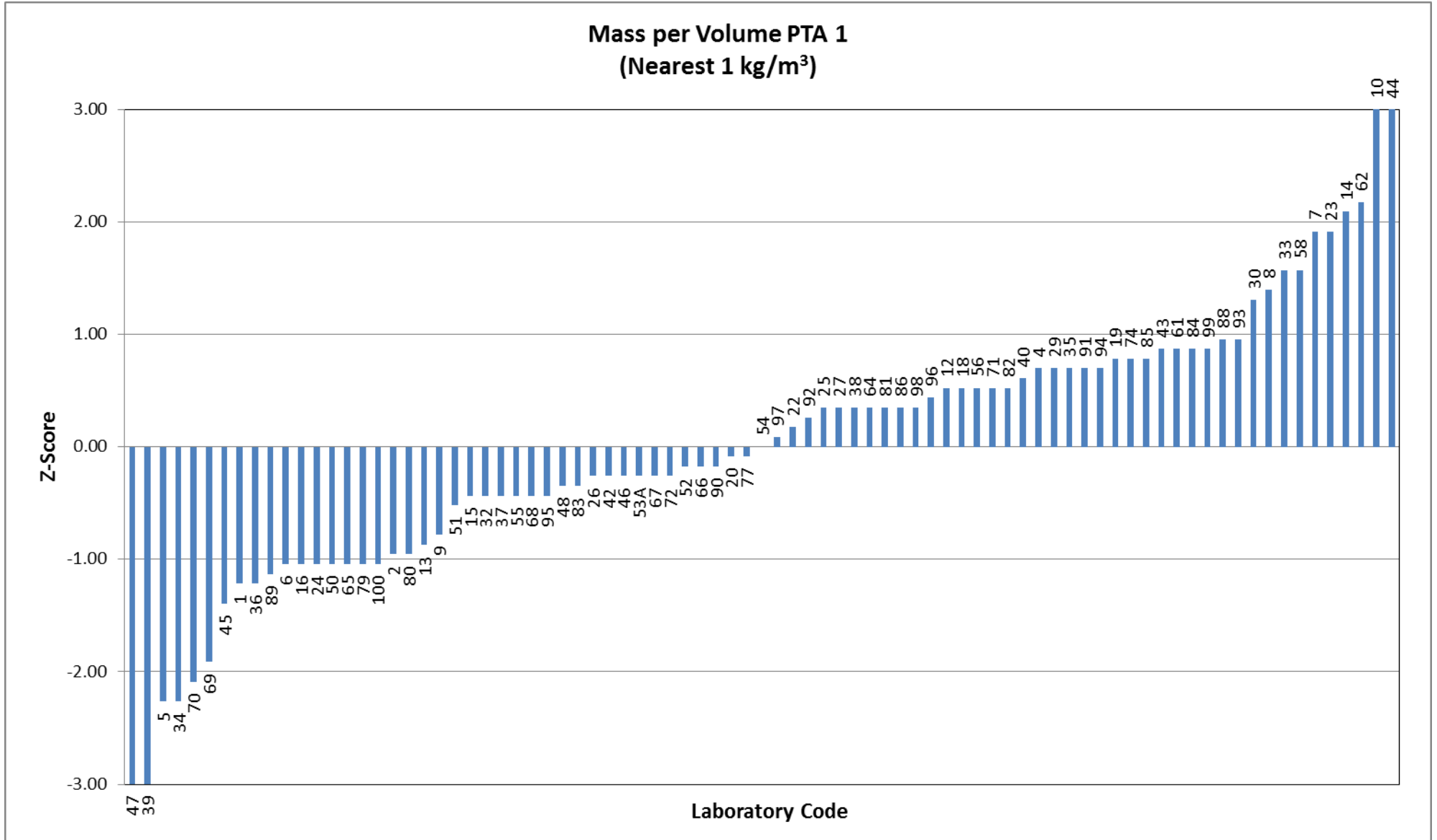
"§" indicates an outlier, i.e.  $|z\text{-score}| \geq 3.0$

Lab Code	Mass/Volume PTA 1 (Nearest 1 kg/m <sup>3</sup> )		
	Result	Z-Score	
1	2358	-1.22	
2	2361	-0.96	
4	2380	0.70	
5	2346	-2.26	?
6	2360	-1.04	
7	2394	1.91	
8	2388	1.39	
9	2363	-0.78	
10	2420	4.18	§
12	2378	0.52	
13	2362	-0.87	
14	2396	2.09	?
15	2367	-0.44	
16	2360	-1.04	
18	2378	0.52	
19	2381	0.78	
20	2371	-0.09	
22	2374	0.17	
23	2394	1.91	
24	2360	-1.04	
25	2376	0.35	
26	2369	-0.26	
27	2376	0.35	
29	2380	0.70	
30	2387	1.31	
32	2367	-0.44	
33	2390	1.57	
34	2346	-2.26	?
35	2380	0.70	
36	2358.0	-1.22	
37	2367	-0.44	
38	2376	0.35	
39	2319	-4.61	§
40	2379	0.61	
42	2369	-0.26	
43	2382	0.87	
44	2445	6.35	§
45	2356	-1.39	
46	2369	-0.26	
47	2044	-28.55	§
48	2368	-0.35	
50	2360	-1.04	

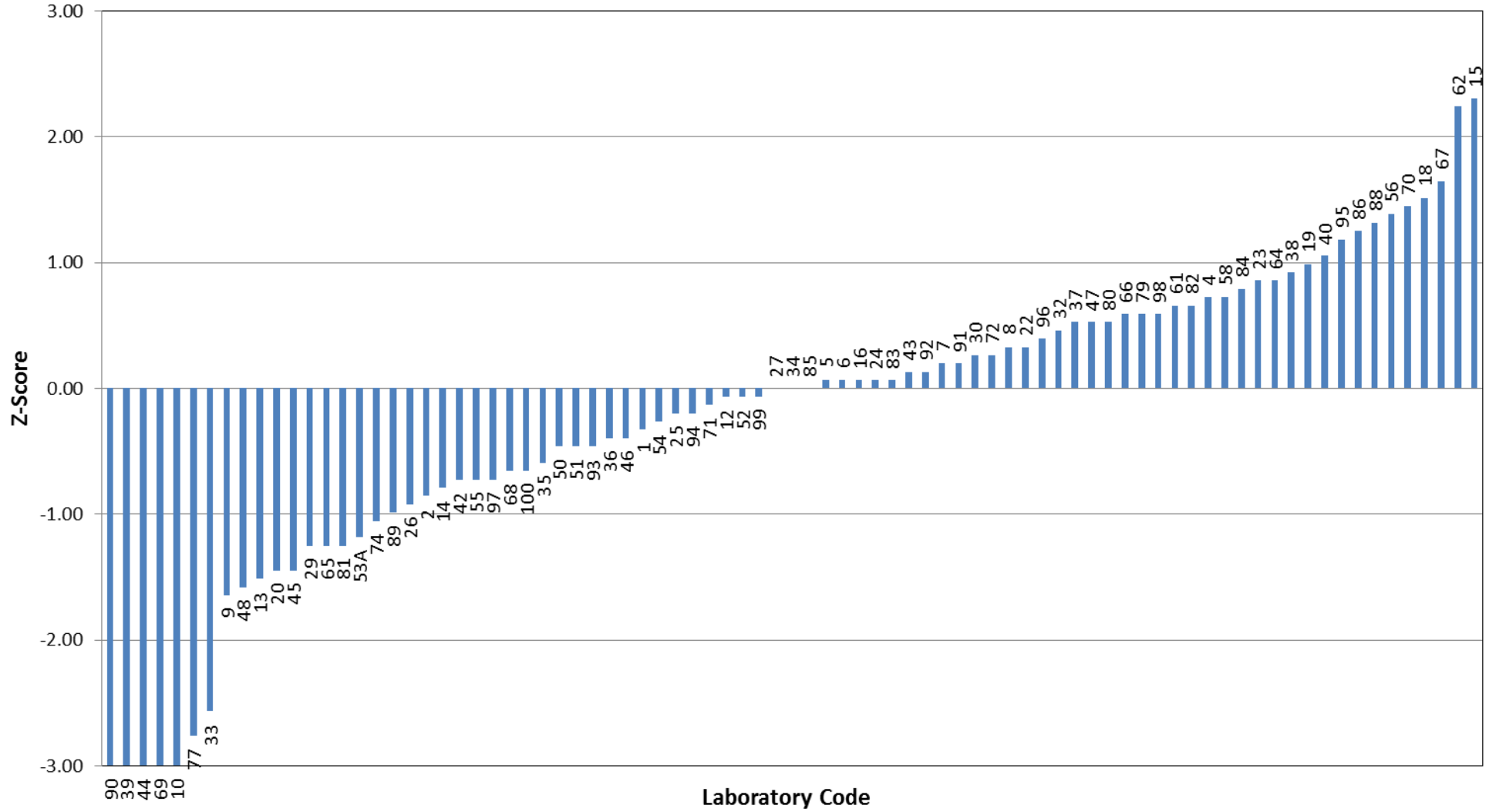
Lab Code	Mass/Volume PTA 1 (Nearest 1 kg/m <sup>3</sup> )		
	Result	Z-Score	
51	2366	-0.52	
52	2370	-0.17	
53A	2369	-0.26	
54	2372	0.00	
55	2367	-0.44	
56	2378	0.52	
58	2390	1.57	
61	2382	0.87	
62	2397	2.18	?
64	2376	0.35	
65	2360	-1.04	
66	2370	-0.17	
67	2369	-0.26	
68	2367	-0.44	
69	2350	-1.91	
70	2348	-2.09	?
71	2378	0.52	
72	2369	-0.26	
74	2381	0.78	
77	2371	-0.09	
79	2360	-1.04	
80	2361	-0.96	
81	2376	0.35	
82	2378	0.52	
83	2368	-0.35	
84	2382	0.87	
85	2381	0.78	
86	2376	0.35	
88	2383	0.96	
89	2359	-1.13	
90	2370	-0.17	
91	2380	0.70	
92	2375	0.26	
93	2383	0.96	
94	2380	0.70	
95	2367	-0.44	
96	2377	0.44	
97	2373	0.09	
98	2376	0.35	
99	2382	0.87	
100	2360	-1.04	

Lab Code	Mass/Volume PTA 2 (Nearest 1 kg/m <sup>3</sup> )		
	Result	Z-Score	
1	2414	-0.33	
2	2406	-0.86	
4	2430	0.72	
5	2420	0.07	
6	2420	0.07	
7	2422	0.20	
8	2424	0.33	
9	2394	-1.65	
10	2370	-3.22	§
12	2418	-0.07	
13	2396	-1.51	
14	2407	-0.79	
15	2454	2.30	?
16	2420	0.07	
18	2442	1.51	
19	2434	0.99	
20	2397	-1.45	
22	2424	0.33	
23	2432	0.86	
24	2420	0.07	
25	2416	-0.20	
26	2405	-0.92	
27	2419	0.00	
29	2400	-1.25	
30	2423	0.26	
32	2426	0.46	
33	2380	-2.57	?
34	2419	0.00	
35	2410	-0.59	
36	2413.0	-0.39	
37	2427	0.53	
38	2433	0.92	
39	2337	-5.40	§
40	2435	1.05	
42	2408	-0.72	
43	2421	0.13	
44	2368	-3.36	§
45	2397	-1.45	
46	2413	-0.39	
47	2427	0.53	
48	2395	-1.58	
50	2412	-0.46	

Lab Code	Mass/Volume PTA 2 (Nearest 1 kg/m <sup>3</sup> )		
	Result	Z-Score	
51	2412	-0.46	
52	2418	-0.07	
53A	2401	-1.18	
54	2415	-0.26	
55	2408	-0.72	
56	2440	1.38	
58	2430	0.72	
61	2429	0.66	
62	2453	2.24	?
64	2432	0.86	
65	2400	-1.25	
66	2428	0.59	
67	2444	1.65	
68	2409	-0.66	
69	2369	-3.29	§
70	2441	1.45	
71	2417	-0.13	
72	2423	0.26	
74	2403	-1.05	
77	2377	-2.76	?
79	2428	0.59	
80	2427	0.53	
81	2400	-1.25	
82	2429	0.66	
83	2420	0.07	
84	2431	0.79	
85	2419	0.00	
86	2438	1.25	
88	2439	1.32	
89	2404	-0.99	
90	2047	-24.48	§
91	2422	0.20	
92	2421	0.13	
93	2412	-0.46	
94	2416	-0.20	
95	2437	1.18	
96	2425	0.39	
97	2408	-0.72	
98	2428	0.59	
99	2418	-0.07	
100	2409	-0.66	



Mass per Volume PTA 2  
(Nearest 1 kg/m<sup>3</sup>)



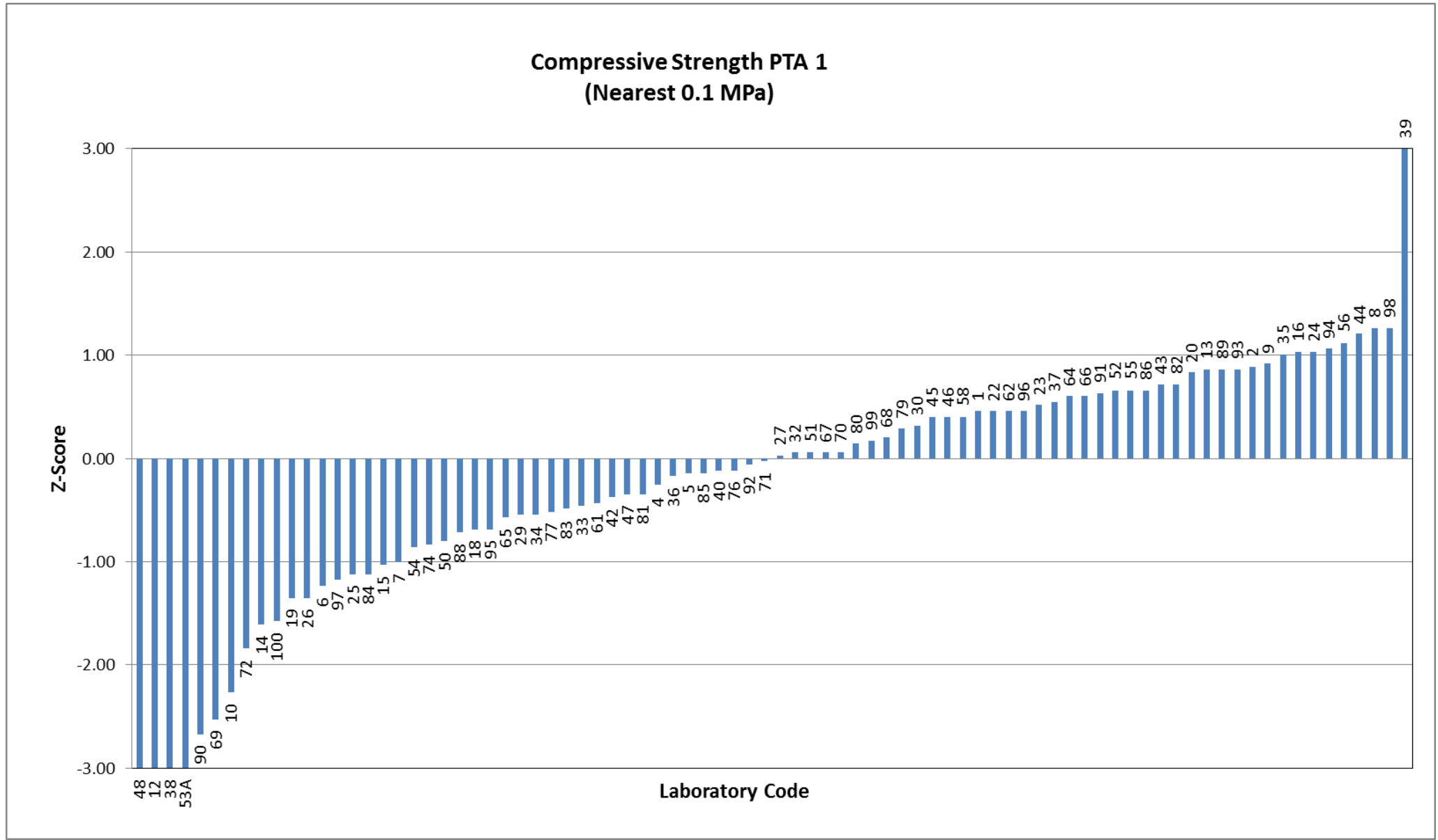
Lab Code	Compressive Strength PTA 1 (Nearest 0.1 MPa)		
	Result	Z-Score	
1	55	0.46	
2	56.5	0.89	
4	52.5	-0.26	
5	52.9	-0.14	
6	49.1	-1.23	
7	49.9	-1.00	
8	57.8	1.26	
9	56.6	0.92	
10	45.5	-2.27	?
12	36.5	-4.85	§
13	56.4	0.86	
14	47.8	-1.61	
15	49.8	-1.03	
16	57	1.03	
18	51	-0.69	
19	48.7	-1.35	
20	56.3	0.83	
22	55	0.46	
23	55.2	0.52	
24	57	1.03	
25	49.5	-1.12	
26	48.7	-1.35	
27	53.5	0.03	
29	51.5	-0.55	
30	54.5	0.32	
32	53.6	0.06	
33	51.8	-0.46	
34	51.5	-0.55	
35	56.9	1.00	
36	52.8	-0.17	
37	55.3	0.55	
38	39.6	-3.96	§
39	69.1	4.51	§
40	53	-0.11	
42	52.1	-0.37	
43	55.9	0.72	
44	57.6	1.21	
45	54.8	0.40	
46	54.8	0.40	
47	52.2	-0.34	
48	36.2	-4.94	§
50	50.6	-0.80	

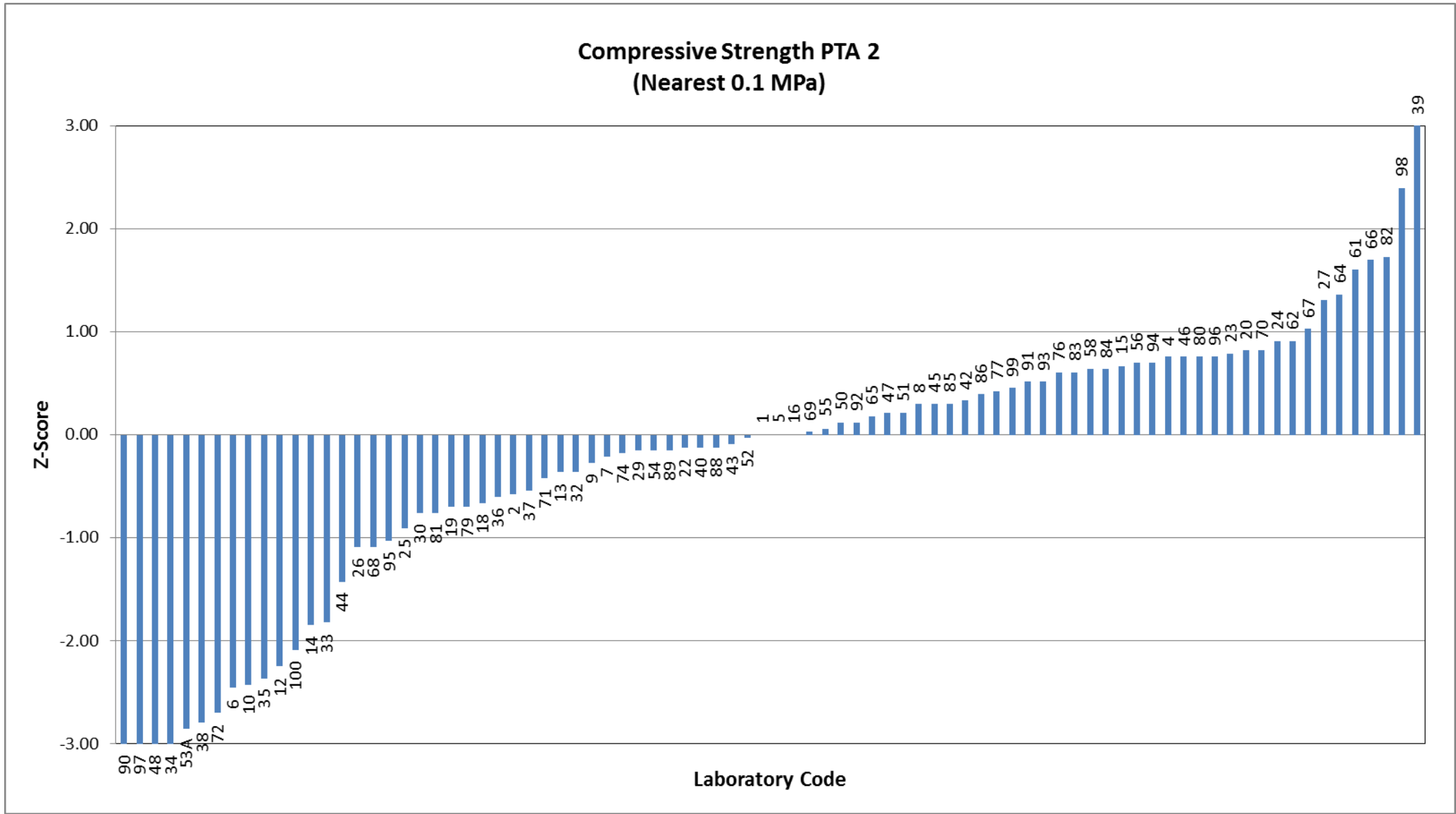
Lab Code	Compressive Strength PTA 1 (Nearest 0.1 MPa)		
	Result	Z-Score	
51	53.6	0.06	
52	55.7	0.66	
53A	42.8	-3.04	§
54	50.4	-0.86	
55	55.7	0.66	
56	57.3	1.12	
58	54.8	0.40	
61	51.9	-0.43	
62	55.0	0.46	
64	55.5	0.60	
65	51.4	-0.57	
66	55.5	0.60	
67	53.6	0.06	
68	54.1	0.20	
69	44.6	-2.53	?
70	53.6	0.06	
71	53.3	-0.03	
72	47	-1.84	
74	50.5	-0.83	
76	53	-0.11	
77	51.6	-0.52	
79	54.4	0.29	
80	53.9	0.14	
81	52.2	-0.34	
82	55.9	0.72	
83	51.7	-0.49	
84	49.5	-1.12	
85	52.9	-0.14	
86	55.7	0.66	
88	50.9	-0.72	
89	56.4	0.86	
90	44.1	-2.67	?
91	55.6	0.63	
92	53.2	-0.06	
93	56.4	0.86	
94	57.1	1.06	
95	51	-0.69	
96	55	0.46	
97	49.3	-1.18	
98	57.8	1.26	
99	54.0	0.17	
100	47.9	-1.58	

Lab Code	Compressive Strength PTA 2 (Nearest 0.1 MPa)		
	Result	Z-Score	
1	59.5	0.00	
2	57.6	-0.58	
4	62	0.76	
5	59.5	0.00	
6	51.4	-2.46	?
7	58.8	-0.21	
8	60.5	0.30	
9	58.6	-0.27	
10	51.5	-2.43	?
12	52.1	-2.24	?
13	58.3	-0.36	
14	53.4	-1.85	
15	61.7	0.67	
16	59.5	0.00	
18	57.3	-0.67	
19	57.2	-0.70	
20	62.2	0.82	
22	59.1	-0.12	
23	62.1	0.79	
24	62.5	0.91	
25	56.5	-0.91	
26	55.9	-1.09	
27	63.8	1.30	
29	59.0	-0.15	
30	57	-0.76	
32	58.3	-0.36	
33	53.5	-1.82	
34	48.5	-3.33	§
35	51.7	-2.36	?
36	57.5	-0.61	
37	57.7	-0.55	
38	50.3	-2.79	?
39	74.9	4.67	§
40	59.1	-0.12	
42	60.6	0.33	
43	59.2	-0.09	
44	54.8	-1.42	
45	60.5	0.30	
46	62	0.76	
47	60.2	0.21	
48	47.4	-3.67	§
50	59.9	0.12	

Lab Code	Compressive Strength PTA 2 (Nearest 0.1 MPa)		
	Result	Z-Score	
51	60.2	0.21	
52	59.4	-0.03	
53A	50.1	-2.85	?
54	59	-0.15	
55	59.7	0.06	
56	61.8	0.70	
58	61.6	0.64	
61	64.8	1.61	
62	62.5	0.91	
64	64	1.36	
65	60.1	0.18	
66	65.1	1.70	
67	62.9	1.03	
68	55.9	-1.09	
69	59.6	0.03	
70	62.2	0.82	
71	58.1	-0.42	
72	50.6	-2.70	?
74	58.9	-0.18	
76	61.5	0.61	
77	60.9	0.42	
79	57.2	-0.70	
80	62	0.76	
81	57.0	-0.76	
82	65.2	1.73	
83	61.5	0.61	
84	61.6	0.64	
85	60.5	0.30	
86	60.8	0.39	
88	59.1	-0.12	
89	59	-0.15	
90	41.4	-5.49	§
91	61.2	0.52	
92	59.9	0.12	
93	61.2	0.52	
94	61.8	0.70	
95	56.1	-1.03	
96	62	0.76	
97	46.6	-3.91	§
98	67.4	2.39	?
99	61	0.45	
100	52.6	-2.09	?







**Summary Statistics**

<b>Mass/Volume (Nearest 1 kg/m<sup>3</sup>)</b>			
<b>PTA 1</b>		<b>PTA 2</b>	
No. of Results	83	No. of Results	83
Median	2372.0	Median	2419.0
Normalised IQR	11.5	Normalised IQR	15.2
Uncertainty of the Median	1.6	Uncertainty of the Median	2.1
Robust CV	0.5%	Robust CV	0.6%
Minimum	2044	Minimum	2047
Maximum	2445	Maximum	2454
Range	401	Range	407

<b>Compressive Strength (Nearest 0.1 MPa)</b>			
<b>PTA 1</b>		<b>PTA 2</b>	
No. of Results	84	No. of Results	84
Median	53.40	Median	59.50
Normalised IQR	3.48	Normalised IQR	3.30
Uncertainty of the Median	0.48	Uncertainty of the Median	0.45
Robust CV	6.5%	Robust CV	5.5%
Minimum	36.2	Minimum	41.4
Maximum	69.1	Maximum	74.9
Range	32.9	Range	33.5

Lab Code	Failure Mode		Date of Receipt	Date of Tests
	PTA 1	PTA 2		
1	#	#	4/04/2018	5/04/2018
2	Normal	Normal	19/03/2018	29/03/2018
4	#	#	29/03/2018	29/03/2018
5	Shear	Shear	26/03/2018	29/03/2018
6	Normal	Normal	20/03/2018	29/03/2018
7	Normal	Normal	20/3/2018	29/03/2018
8	Cone	Shear	#	29/03/2018
9	N	N	26/03/2018	29/03/2018
10	Normal	Normal	21/03/2018	29/03/2018
12	Crushing and shear	Crushing and shear	22/03/2018	29/03/2018
13	N	N	29/03/2018	29/03/2018
14	Satisfactory	Satisfactory	23/03/2018	29/03/2018
15	Cone	Cone	14/03/2018	29/03/2018
16	Normal	Normal	20/03/2018	29/03/2018
18	Normal - cone	Normal - cone	20/03/2018	29/03/2018
19	Conical	Conical	15/03/2018	29/03/2018
20	Shear	Cone & Shear	14/03/2018	6/04/2018
22	Shear	Shear	20/03/2018	29/03/2018
23	Shear	Normal	22/03/2018	29/03/2018
24	Normal	Normal	20/03/2018	29/03/2018
25	N	N	19/03/2018	29/03/2018
26	B-Cone and split	C-Cone and shear	20/03/2018	29/03/2018
27	Type 3	Type 3	2/04/2018	2/04/2018
29	Shear	Shear	26/03/2018	29/03/2018
30	Compressive	Compressive	20/03/2018	29/03/2018
32	S.	S.	15/03/2018	29/03/2018
33	Type 3	Type 3	19/03/2018	29/03/2018
34	Shear-conic	Shear-conic	20/03/2018	29/03/2018

Lab Code	Failure Mode		Date of Receipt	Date of Tests
	PTA 1	PTA 2		
35	Compressive	Compressive	16/03/2018	29/03/2018
36	Cone / Shear	Cone	21/03/2018	29/03/2018
37	Type 2	Type 2	19/03/2018	29/03/2018
38	#	#	20/03/2018	29/03/2018
39	Cone	Sheer	16/03/2018	29/03/2018
40	#	#	19/03/2018	29/03/2018
42	N	N	19/03/2018	29/03/2018
43	Normal	Normal	20/03/2018	29/03/2018
44	#	#	16/03/2018	29/03/2018
45	N	N	20/03/2018	29/03/2018
46	Normal	Normal	19/03/2018	29/03/2018
47	Sheer	Sheer	22/03/2018	29/03/2018
48	N	N	26/03/2018	11/04/2018
50	N	N	22/03/2018	29/03/2018
51	Normal (cone)	Normal (cone)	16/03/2018	29/03/2018
52	Normal	Shear	15/03/2018	29/03/2018
53A	Vertical splitting	Vertical splitting	22/03/2018	29/03/2018
54	Normal	Normal	21/03/2018	29/03/2018
55	Normal	Normal	4/04/2018	4/04/2018
56	Compressive	Compressive	22/03/2018	29/03/2018
58	Double shears	Axaial multiple	#	29/03/2018
61	Normal	Normal	20/03/2018	29/03/2018
62	Compressive	Compressive	22/03/2018	29/03/2018
64	Normal	Normal	16/03/2018	29/03/2018
65	Shear	Compressive	13/03/2018	29/03/2018
66	Compressive	Compressive	22/03/2018	29/03/2018
67	Normal Shear	Normal shear	22/03/2018	4/04/2018

Lab Code	Failure Mode		Date of Receipt	Date of Tests
	PTA 1	PTA 2		
68	#	#	20/03/2018	29/03/2018
69	Normal	Normal	9/04/2018	10/04/2018
70	Normal	Normal	20/03/2018	29/03/2018
71	Cone and split	Vertical split	15/03/2018	29/03/2018
72	Normal	Normal	17/03/2018	29/03/2018
74	Normal	Normal	19/03/2018	29/03/2018
76	D (Shear)	B (Cone and split)	29/03/2018	29/03/2018
77	Side fracture (top)	Axial split (top) to cone (bottom)	21/03/2018	29/03/2018
79	Cone	Cone	20/03/2018	29/03/2018
80	Cone	Normal	20/03/2018	29/03/2018
81	Shear	Normal	21/03/2018	29/03/2018
82	Compressive	Compressive	22/03/2018	29/03/2018
83	Top shear	Cone and shear	20/03/2018	29/03/2018
84	Cone/Split	Columnar	16/03/2018	29/03/2018
85	C	C	20/03/2018	29/03/2018
86	Normal	Normal	20/03/2018	29/03/2018
88	Shear	Cone	19/03/2018	29/03/2018
89	Shear	Shear	20/03/2018	29/03/2018
90	Well-formed cone on one end, vertical cracks running through height. No well formed cone in other end.	Well-formed cone on one end, vertical cracks running through height. No well formed cone in other end.	4/04/2018	4/04/2018
91	Compressive	Compressive	22/03/2018	29/03/2018
92	N	N	16/03/2018	29/03/2018
93	Compressive	Compressive	22/03/2018	29/03/2018
94	Normal	Normal	15/03/2018	29/03/2018
95	Shear	Shear	19/03/2018	29/03/2018
96	Conic	Conic	20/03/2018	6/04/2018

Lab Code	Failure Mode		Date of Receipt	Date of Tests
	PTA 1	PTA 2		
97	Type 1	Type 1	24/03/2018	29/03/2018
98	Cone+Shear	Cone Split	23/03/2018	29/03/2018
99	B Cone and split	B Cone and split	20/03/2018	29/03/2018
100	Normal	Shear	16/03/2018	29/03/2018

Note: “#” indicates no response was provided by the laboratory

<b>Lab Code</b>	<b>Moisture Condition</b>	<b>Average Temperature Curing Tank</b>	<b>End Treatment</b>	<b>Method</b>
<b>1</b>	SSD	NA	Grinded	AS 1012
<b>2</b>	SSD	22.75°C	Sulphur cap	AS 1012
<b>4</b>	SSD	23°C	Rubber	1012.9
<b>5</b>	SSD	23°C	Rubber cap	AS 1012.9
<b>6</b>	SSD	23.0°C	Sulphur capped	AS 1012.9
<b>7</b>	SSD	22°C	Sulphur cap	AS 1012.9
<b>8</b>	SSD	24.5°C	Rubber cap	1012
<b>9</b>	SSD	23°C	Rubber cap	AS 1012
<b>10</b>	SSD	25°C	Rubber capping	AS 1012
<b>12</b>	SSD	26°C	Sulphur capping	AS 1012.9
<b>13</b>	SSD	23°C	Rubber cap	AS 1012
<b>14</b>	SSD	26°C	Capping	MS 26 Part 2:1991
<b>15</b>	SSD	23°C	Rubber cap	AS 1012
<b>16</b>	SSD	26°C	Rubber	AS 1012.9, AS 1012.12.1
<b>18</b>	SSD	24°C	Sulphur/Flyash capped	AS 1012.9, AS 1012.12.2
<b>19</b>	SSD	26.5°C	Grind	AS 1012.9
<b>20</b>	Dry	25°C	Rubber capped	AS 1012.9
<b>22</b>	SSD	24°C	Rubber capped	AS 1012
<b>23</b>	SSD	23°C	Ground	AS 1012.9
<b>24</b>	SSD	23°C	Ground	AS 1012.9-2014
<b>25</b>	SSD	22-24°C	Sulphur capping	AS 1012 - Avery crushing machine
<b>26</b>	SSD	26.7°C	Rubber cap	AS 1012.9
<b>27</b>	SSD	21.5°C	Rubber	INV E-410-2013
<b>29</b>	SSD	24°C	Rubber capping	AS 1012
<b>30</b>	SSD	23°C	Ground	AS 1012.9
<b>32</b>	SSD	27°C	Rubber cap	AS 1012



Lab Code	Moisture Condition	Average Temperature Curing Tank	End Treatment	Method
33	SSD	26°C	Sulphur capped	AS 1012.9
34	PTA 1 -SSD, PTA 2 dry	23.8°C	Rubber capping	AS 1012.9, AS 1012.12.1
35	Dry	27°C	Sulphur	AS 1012.9
36	SSD	22.3°C - 22.6°C	Sulphur cap	AS 1012.9, AS 1012.12.1
37	SSD	21.8°C	Rubber cap	ASTM C39M-18
38	SSD	20±1°C	#	KS F 2405
39	SSD	29°C	Rubber capped	AS 1012
40	SSD	23°C	Double ends ground	AS 1012.9, AS 1012.12.1
42	SSD	23°C	Sulphur capped	AS 1012.9 clause 6.2.2(a)
43	SSD	29°C	Rubber	AS 1012.9
44	SSD	28°C	Rubber	AS 1012.8.1, AS 1012.9
45	SSD	23°C	Rubber cap	AS 1012.12.1, AS 1012.9
46	SSD	27°C	Ground	AS 1012.9, AS 1012.12.1
47	SSD	22.9°C	Rubber cap	AS 1012.9
48	SSD	26°C	End grinding, Ground flat	AS 1012.9:2014
50	Moist and wet	24°C	Sulphur cap	1012.9:2014
51	SSD	26.5°C	Rubber capped	AS 1012.9, AS 1012.12.1
52	SSD	27°C	Rubber cap	AS 1012
53A	SSD	23.0°C	Ground	AS 1012.9
54	SSD	22-24°C	Sulphur	AS 1012.9
55	SSD	#	Sulphur Capped	AS 1012.9, AS1012.12.1
56	SSD	27±2°C	Ground	AS 1012.9
58	SSD	23.2°C	Rubber cap	AS 1012.9
61	SSD	23°C	Rubber cap	AS 1012.9
62	SSD	27±2°C	Ground	AS 1012.9
64	SSD	27.9°C	Rubber cap	AS 1012

Lab Code	Moisture Condition	Average Temperature Curing Tank	End Treatment	Method
65	SSD	27.3	Rubber	AS 1012
66	SSD	27±2°C	Ground	AS 1012.9
67	SSD Moist	23.8°C	Rubber cap	AS 1012.9, AS 1012.12.1
68	#	22.9°C	Rubber cap	AS 1012
69	SSD	26°C	Restrained natural rubber cap	AS 1012.9:2014
70	SSD	23°C	Rubber cap	AS 1012.9, AS 1012.12.1
71	SSD	26°C	Sulphur capping	AS 1012.9:2014
72	SSD	27°C	Sulphur capping	AS 1012.12.1, AS 1012.9
74	SSD	28°C	Sulphur capping	AS 1012.12.1, AS 1012.9
76	SSD	23°C	Rubber cap	AS 1012.9
77	SSD	23°C	Rubber capped	AS 1012.12.1, AS 1012.9
79	SSD	24°C	Rubber cap	AS 1012.9, AS 1012.12.2
80	SSD	23°C	Rubber cap	AS 1012.9, AS 1012.12.1
81	50/50 SSD/DRY	22°C	Sulphur capped	AS 1012.9, AS 1012.12.1
82	SSD	27±2°C	Ground	AS 1012.9
83	SSD	23.6°C	Rubber cap	AS 1012.9
84	SSD	21°C	1 – Plaster Cap	NZS 3112.2, NZS 3112.3
85	SSD	28°C	Rubber cap	AS 1012.9
86	SSD	21.8°C	Rubber capping	AS 1012
88	SSD	23°C	Rubber cap	AS 1012.9
89	SSD	Tropical 27±2°C	End grinding machine + rubber cap	AS 1012.9
90	SSD	#	Grinding	BOS 27:2000
91	SSD	27±2°C	Ground	AS 1012.9
92	SSD	27°C	Ground	AS 1012 clause 5 (a-ii)
93	SSD	27±2°C	Ground	AS 1012.9
94	SSD	23.4°C	Ground	AS 1012

<b>Lab Code</b>	<b>Moisture Condition</b>	<b>Average Temperature Curing Tank</b>	<b>End Treatment</b>	<b>Method</b>
<b>95</b>	SSD	23°C	Ground and rubber cap	AS 1012.9:2014
<b>96</b>	SSD	21°C	Rubber cap	NZS 3112
<b>97</b>	SSD	22°C	Sulphur capping	ASTM C39-16b
<b>98</b>	SSD	23.9°C	Rubber cap	AS 1012.9
<b>99</b>	SSD	26.5°C	Rubber cap	AS 1012.9
<b>100</b>	SSD	27°C	Ground	AS 1012

Note: “#” indicates no response was provided by the laboratory

# **APPENDIX B**

## **Homogeneity Testing**

The homogeneity acceptance criteria for MPUV is  $\pm 1.6\%$  of the mean and for Compressive Strength is  $\pm 7\%$  of the mean. The homogeneity results were found to be satisfactory.

Concrete Round 23 Homogeneity Results										
PTA 1										
Sample Number	Date Sampled	Date Tested	Height (mm)	Average Diameter (mm)	Weight	Mass per Unit Volume (kg/m <sup>3</sup> )	Compressive Strength (Mpa)	Age of Specimen (Days)	Capping Method	Condition of Specimen
13	13/02/2018	29/03/2018	200	100.2	3723	2361	49.1	44	Rubber	SSD
27	13/02/2018	29/03/2018	201	100.2	3746	2359	50.8	44	Rubber	SSD
32	13/02/2018	29/03/2018	200	100.2	3714	2355	52.1	44	Rubber	SSD
44	13/02/2018	29/03/2018	201	100.2	3732	2352	48.7	44	Rubber	SSD
58	13/02/2018	29/03/2018	201	100.2	3739	2359	48.6	44	Rubber	SSD
66	13/02/2018	29/03/2018	201	100.4	3750	2357	49.4	44	Rubber	SSD
76	13/02/2018	29/03/2018	200	100.2	3737	2370	50.8	44	Rubber	SSD
95	13/02/2018	29/03/2018	201	100.2	3728	2352	49.2	44	Rubber	SSD
<b>Mean</b>			200.63	100.23	3733.6	2358.13	49.84			
<b>Standard Deviation</b>			0.52	0.07	11.92	5.82	1.25			
<b>Coefficient of Variation</b>			0.26%	0.07%	0.32%	0.25%	2.51%			
<b>Lowest Value</b>			200	100.2	3714	2352	48.6			
<b>Highest Value</b>			201	100.4	3750	2370	52.1			

Concrete Round 23 Homogeneity Results										
PTA 2										
Sample Number	Date Sampled	Date Tested	Height (mm)	Average Diameter (mm)	Weight	Mass per Unit Volume (kg/m <sup>3</sup> )	Compressive Strength (Mpa)	Age of Specimen (Days)	Capping Method	Condition of Specimen
15	14/02/2018	29/03/2018	199	100	3785	2422	55.5	43	Rubber	SSD
17	14/02/2018	29/03/2018	200	100.2	3805	2422	56.7	43	Rubber	SSD
37	14/02/2018	29/03/2018	199	100.2	3767	2400	56.2	43	Rubber	SSD
47	14/02/2018	29/03/2018	200	100.2	3800	2410	61	43	Rubber	SSD
61	14/02/2018	29/03/2018	199	100	3784	2421	58.7	43	Rubber	SSD
78	14/02/2018	29/03/2018	199	100.2	3778	2408	57.9	43	Rubber	SSD
84	14/02/2018	29/03/2018	199	100.2	3777	2407	55.5	43	Rubber	SSD
85	14/02/2018	29/03/2018	200	100.2	3781	2398	55.9	43	Rubber	SSD
<b>Mean</b>			199.38	100.15	3784.6	2411	57.18			
<b>Standard Deviation</b>			0.52	0.09	12.41	9.70	1.92			
<b>Coefficient of Variation</b>			0.26%	0.09%	0.33%	0.40%	3.36%			
<b>Lowest Value</b>			199	100	3767	2398	55.5			
<b>Highest Value</b>			200	100.2	3805	2422	61			

# APPENDIX C

## Documentation

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

PROFICIENCY TESTING AUSTRALIA  
Proficiency Testing Program

Concrete Round 23

**INSTRUCTIONS TO PARTICIPANTS**

**PLEASE NOTE CYLINDERS ARE TO BE TESTED ON THE 29 MARCH.**

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

If you receive your cylinders after this date place them in the curing tank and test them as soon as possible.

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>o</sup>C) of the curing tank water until tested.
7. Remove and test the cylinders marked PTA 1 and PTA 2 on **29 March**.
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 **6 April** to:

**Emilia Cincu**  
**Proficiency Testing Australia**  
**Fax: 02 9743 6664**  
**Email: emilia.cincu@pta.asn.au**

**PROFICIENCY TESTING AUSTRALIA**  
**Concrete 23 - Proficiency Testing Program**

**Results Sheet**

**TEST DATE: 29 March 2018**

**Lab 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)		
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 & PTA 2: \_\_\_\_\_

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

Return no later than **Friday 6 April** to:

**Emilia Cincu**

**Proficiency Testing Australia**

**Phone: 02 9736 8397**

**Fax: 02 9743 6664**

**Email: emilia.cincu@pta.asn.a**

*- End of Report -*