

Report No. 1083

Concrete Proficiency Testing Program

Round 24

July 2018

Acknowledgments

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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-fourth round of an ongoing series of programs.

The program was conducted in April-May 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 Soil Engineering Services, Brisbane, QLD. This report was authorised by Mrs K Cividin, PTA Quality Manager.

2. FEATURES OF THE PROGRAM

- (a) Participants were provided with two concrete cylinders labelled PTA 3 and PTA 4.
- (b) A total of 31 laboratories received samples, comprising:
 - 21 Australian participants; and
 - 10 overseas participants, including:
 - Cyprus (1);
 - Kenya (1);
 - Peru (1);
 - Qatar (1); and
 - Saudi Arabia (6).

All laboratories were able 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.

- (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 and z-score charts for Mass/Volume and Compressive Strength 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 no. 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 no. 8 summarises the outlier results detected.

(b) Results Tables and Summary Statistics

Each of these tables contains the results returned by each laboratory and where applicable, 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 the tables of results for Mass/Volume 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.

In this round, the spread of results for Compressive Strength was considered too large compared to previous rounds (Robust CV 9.8% for PTA 3 and 10.9% for PTA 4). As a result, a target coefficient of variation (CV) was used to calculate the z-scores .

The target CV, expressed as a percentage, is a fixed value used to calculate the z-score when the spread of results is too large. Its value is determined based on previous rounds of the program. For this program, a target CV of 5.5% was used.

The target standard deviation (SD) is calculated as the target CV multiplied by the median.

In the particular case of Compressive Strength, the robust z-score (denoted by Z) for a laboratory's sample A result was calculated as:

$$Z = \frac{A - \text{median}(A)}{\text{target SD}(A)}$$

where A is a sample in a testing program.

(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

Test	No. of Results	Median	Minimum	Maximum
Height - PTA 3 (Nearest 1 mm)	31	200.0	195	200
Height - PTA 4 (Nearest 1 mm)	31	200.0	195	200
Diameter PTA 3 (Nearest 0.2 mm)	31	100.10	99.4	100.4
Diameter PTA 4 (Nearest 0.2 mm)	31	100.10	99.8	100.4
Weight PTA 3 (Nearest 1 g)	31	3741.0	3.756	3769
Weight PTA 4 (Nearest 1 g)	31	3777.0	3.778	3825
Maximum Sustained Load Unit PTA 3 (Nearest 1 kN)	31	404.0	91	452
Maximum Sustained Load Unit PTA 4 (Nearest 1 kN)	31	385.1	286	423

TABLE A-2: SUMMARY STATISTICS

Test	No. of Results	Median	Normalised IQR	Robust CV (%)
Mass/Volume PTA 3 (Nearest 1 kg/m ³)	31	2379.0	11.9	0.5%
Mass/Volume PTA 4 (Nearest 1 kg/m ³)	31	2405.0	7.4	0.3%
Compressive Strength PTA 3 (Nearest 0.1 MPa)	31	51.30	5.00	9.8%
Compressive Strength PTA 4 (Nearest 0.1 MPa)	31	49.00	5.34	10.9%

5. PTA AND TECHNICAL ADVISER'S COMMENTS

A total of 31 laboratories (21 Australian and 10 overseas) participated in this round. All laboratories submitted the results in time to be included in the final report.

Overall performance against prior expectations

In total nine outliers were detected from the 124 results analysed, resulting in 7.2% of results classified as outliers which was similar to previous rounds. Compressive Strength test for sample PTA 3 showed a higher number of outliers compared to previous years, while the Mass/Volume determination for sample PTA 3 had no outlier results. 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.

Variations between laboratories

Table B gives a comparison of the robust CVs for tests common to previous programs. The CV values for Compressive Strength in this round are much higher than those from previous rounds (Robust CV 9.8% for PTA 3 and 10.9% for PTA 4). Therefore, a target CV was used to calculate the z-scores (see “Statistical Design of the Program” pages 3 and 4).

Variations between test methods and procedures

The majority of participants performed the required testing using AS 1012.9 and AS 1012.12. Other test methods used include ASTM C39/C39M-18, ASTM C617/C617M-15, BS EN 12390-3:2009, BS EN 12390-1:2012 and BS EN 12390-7:2009.

Possible sources of error and suggestions for improvement

Laboratory 9 reported extreme results for the Weight test. A possible cause of this error might be the recording of the results in a wrong unit of measurement (e.g. Kg instead of g).

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

- the condition of the concrete specimens (damage during dispatch, late testing)
- interpretation of test methods and procedures
- calibration of laboratory instruments
- incorrect calculations
- mistakes whilst 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 isolate any anomalies found.

TABLE B: COMPARISON OF PREVIOUS ROUND CVs

Test	Round 20	Round 21	Round 22	Round 23	Round 24	
Mass/Volume PTA 1 (Nearest 1 kg/m ³)	0.5%	0.5%	0.7%	0.5%	0.5%	PTA 3
Mass/Volume PTA 2 (Nearest 1 kg/m ³)	0.7%	0.5%	0.1%	0.6%	0.3%	PTA 4
Compressive Strength PTA 1 (Nearest 0.1 MPa)	4.2%	4.8%	5.7%	6.5%	9.8%	PTA 3
Compressive Strength PTA 2 (Nearest 0.1 MPa)	4.4%	4.7%	6.8%	5.5%	10.9%	PTA 4

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 the Standard Operating Procedures of Soil Engineering Services to ensure samples were homogeneous and appropriate for the program. Please refer to Appendix B for homogeneity results.

Analysis of Results by Method Groups

In order for methods to be grouped for analysis, PTA requires at least 11 sets of results from the same method group. Therefore, further analysis of results by Method AS 1012.9 was undertaken to provide specific information on individual method performance for Compressive Strength. Table C below presents the Median, Uncertainty of the Median and Robust CV of the results obtained by this method.

TABLE C: SUMMARY OF GROUP ANALYSIS

Test	Method	Sample	Number of Results	Median	Uncertainty of the Median	Robust CV
Compressive Strength (Nearest 0.1 MPa)	AS 1012.9	PTA 3	14	51.70	0.97	5.6%
		PTA 4	14	49.60	0.52	3.1%

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 3 (Nearest 1 kg/m ³)	-
Mass/Volume PTA 4 (Nearest 1 kg/m ³)	10, 17, 30
Compressive Strength PTA 3 (Nearest 0.1 MPa)	4, 18, 26, 27
Compressive Strength PTA 4 (Nearest 0.1 MPa)	4, 12

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

Test	Round 20	Round 21	Round 22	Round 23	Round 24	
Mass/Volume PTA 1 (Nearest 1 kg/m ³)	11.5%	5.9%	5%	4.8%	0%	PTA 3
Mass/Volume PTA 2 (Nearest 1 kg/m ³)	9.6%	3.9%	3.3%	6%	9.6%	PTA 4
Compressive Strength PTA 1 (Nearest 0.1 MPa)	5.7%	7.8%	8.3%	5.9%	12.9%	PTA 3
Compressive Strength PTA 2 (Nearest 0.1 MPa)	9.4%	5.9%	8.3%	5.9%	6.4%	PTA 4

7. REFERENCES

- [1] *Guide to Proficiency Testing Australia, 2016* (This document can be found on the PTA website, www.pta.asn.au)
- [2] *AS 1012.9:2014 Methods for testing concrete. Compressive strength tests - Concrete, mortar and grout specimens*
- [3] *AS 1012.12.1:1998 (R2014) Methods of testing concrete. Determination of mass per unit volume of hardened concrete - Rapid measuring method*
- [4] *ASTM C39/C39M-18 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*
- [5] *ASTM C39/C39M-17A Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*
- [6] *ASTM C617/C617M-15 Standard Practice for Capping Cylindrical Concrete Specimens*
- [7] *BS EN 12390-3:2009 Testing hardened concrete. Compressive strength of test specimens.*
- [8] *BS EN 12390-1:2012 Testing hardened concrete. Shape, dimensions and other requirements for specimens and moulds.*
- [10] *BS EN 12390-7:2009 Testing hardened concrete. Density of hardened concrete.*

APPENDIX A

Results and Data Analysis

Height (Nearest 1 mm).....	A1
Diameter (Nearest 0.2 mm).....	A2
Weight (Nearest 1 g).....	A3
Maximum Sustained Load Unit (Nearest 1 kN).....	A4
Mass/Volume (Nearest 1 kg/m ³).....	A5
Compressive Strength (Nearest 0.1 MPa).....	A9
Other Information.....	A13

Lab Code	Height (Nearest 1 mm)	
	PTA 3	PTA 4
1	199	199
2	200	200
3	200	200
4	200	200
5	200	199
6	200	200
7	200	200
8	199	199
9	200	199
10	200	200
11	199	199
12	200	200
13	199.94	199.91
14	200	200
15	197	197
16	200	200
17	200	200
18	200	200
19	199	200
20	200	200
21	200	199
22	195	195
23	200	200
24	200	200
25	200	200
26	199	200
27	200	200
28	195	195
29	200	200
30	197	198
31	200	200

No. of Results	31	31
Median	200.0	200.0
Minimum	195	195
Maximum	200	200

Lab Code	Diameter PTA 3 (Nearest 0.2 mm)		
	Result 1	Result 2	Average
1	100.4	#	100.4
2	100.2	100.2	100.2
3	100.2	#	100.2
4	100	#	100
5	100.0	100.0	100.0
6	100.2	#	100.2
7	100.2	100.0	100.1
8	100.0	#	100.0
9	100.4	#	100.4
10	99.4	#	99.4
11	100.2	100.0	100.1
12	99.92	#	99.9
13	100.29	#	100.29
14	100.0	#	100.0
15	100.2	#	100.2
16	100.1	#	100.1
17	100.2	100.2	100.2
18	100.2	#	100.2
19	100.2	100.0	100.1
20	100	100	100.0
21	100.00	#	100.00
22	100.0	#	100.0
23	100.1	#	100.1
24	100.2	#	100.2
25	100.0	#	100.0
26	100.0	#	100.0
27	100.17	#	100.2
28	100.0	#	100.0
29	100.2	#	100.2
30	100.2	#	100.2
31	100.0	#	100.0

Lab Code	Diameter PTA 4 (Nearest 0.2 mm)		
	Result 1	Result 2	Average
1	100.2	#	100.2
2	100.2	100.0	100.1
3	100.0	#	100.0
4	100	#	100
5	100.2	100.2	100.2
6	100.0	#	100.0
7	100.2	100.2	100.2
8	100.1	#	100.1
9	100.2	#	100.2
10	99.8	#	99.8
11	100.2	100.0	100.1
12	99.98	#	99.98
13	100.17	#	100.17
14	100.0	#	100.0
15	100.0	#	100.0
16	100.1	#	100.1
17	100.2	100.2	100.2
18	100.2	#	100.2
19	100.2	100.0	100.1
20	100	100	100
21	100.00	#	100.00
22	100.0	#	100.0
23	100.1	#	100.1
24	100.4	#	100.4
25	100.2	#	100.2
26	100.0	#	100.0
27	100.20	#	100.20
28	100.0	#	100.0
29	100.2	#	100.2
30	100.0	#	100.0
31	100.0	#	100.0

No. of Results	31
Median	100.10
Minimum	99.4
Maximum	100.4

No. of Results	31
Median	100.10
Minimum	99.8
Maximum	100.4

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

Lab Code	Weight (Nearest 1 g)	
	PTA 3	PTA 4
1	3738	3777
2	3732	3767
3	3732	3784
4	3745	3792
5	3735	3782
6	3727	3770
7	3744	3777
8	3725.0	3793.0
9	3.756	3.778
10	3743	3825
11	3742	3766
12	3769	3744
13	3744.7	3785.6
14	3753	3789
15	3690	3727
16	3742	3777
17	3744	3732
18	3734	3788
19	3741	3795
20	3743	3784
21	3741.7	3770.7
22	3656	3691
23	3727	3782
24	3729	3788
25	3728	3788
26	3751	3771
27	3740	3773
28	3648	3709
29	3758	3787
30	3742	3695
31	3744	3779

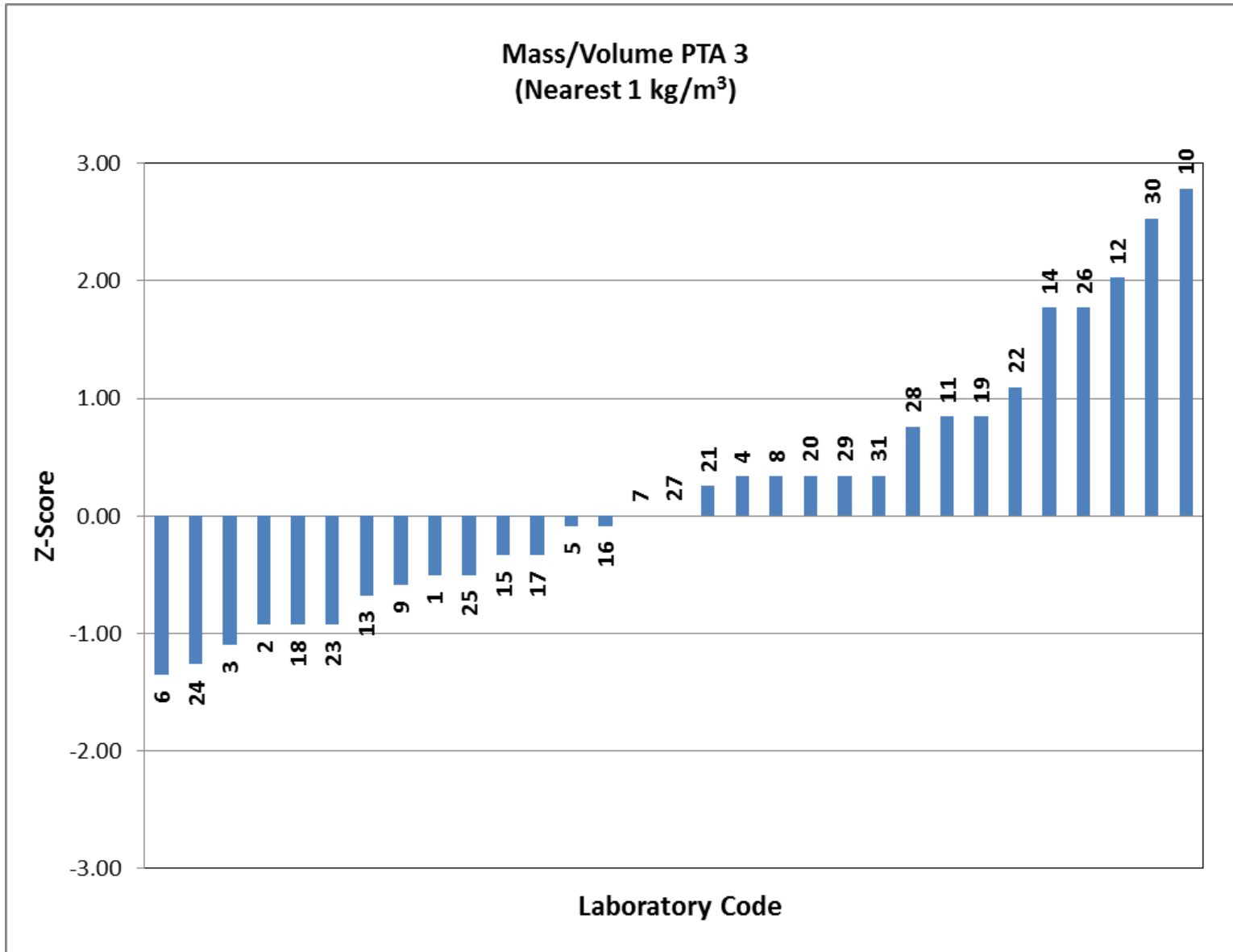
No. of Results	31	31
Median	3741.0	3777.0
Minimum	3.756	3.778
Maximum	3769	3825

Lab Code	Maximum Sustained Load Unit (Nearest 1 kN)	
	PTA 3	PTA 4
1	351	342
2	401.5	385.1
3	426	399
4	326	286
5	424	383
6	402	376
7	415	398
8	382	344
9	431	388
10	336	339
11	404	400
12	352	320
13	428.1	392.9
14	432	404
15	417	382
16	361	332
17	393.4	395.4
18	91	334
19	409	386
20	426	402
21	414	378
22	409	397
23	452	421
24	401	372
25	414	402
26	305	335
27	318	323
28	395	365
29	423	394
30	379	423
31	435	407

No. of Results	31	31
Median	404.0	385.1
Minimum	91	286
Maximum	452	423

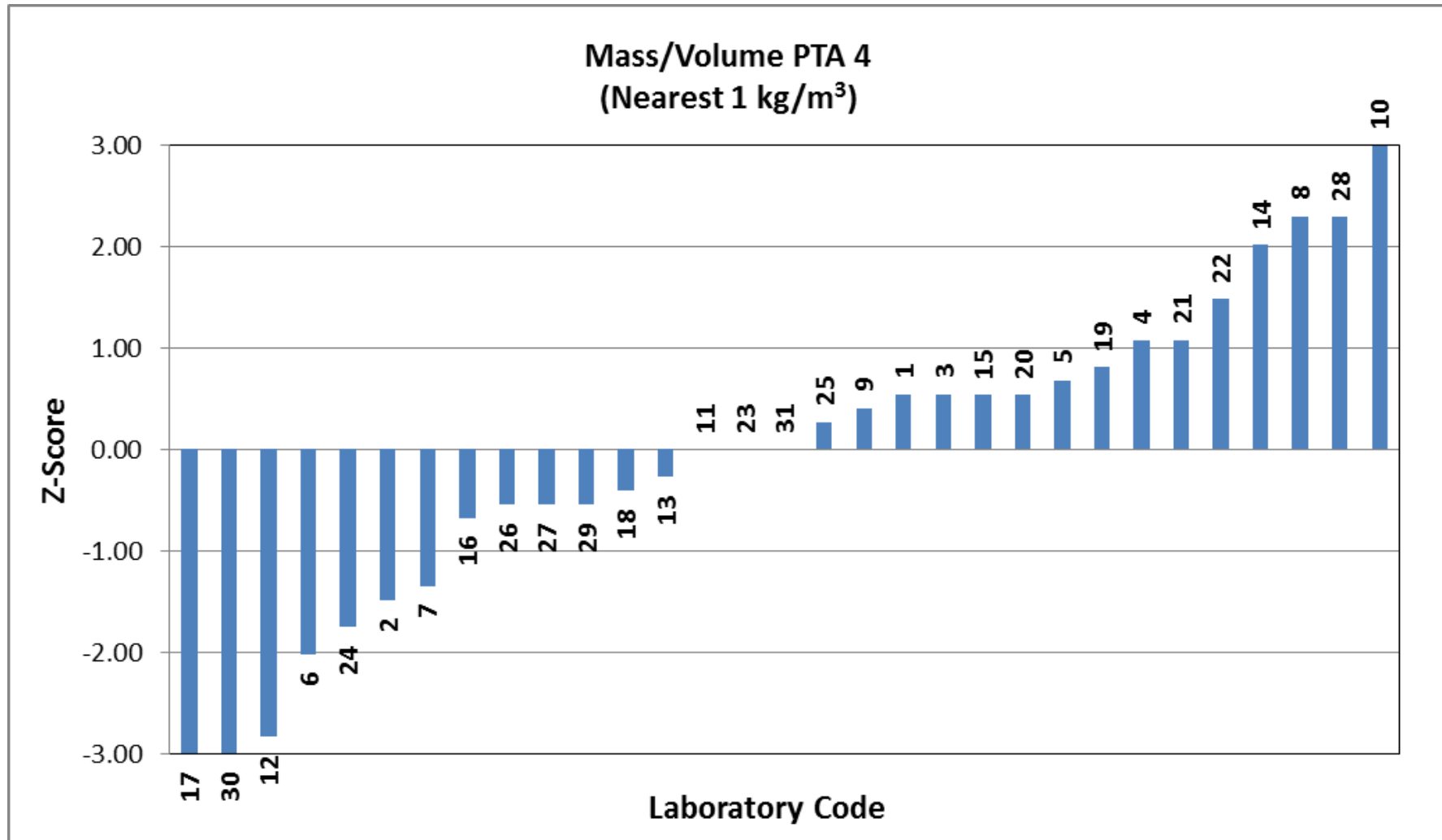
Lab Code	Mass/Volume (Nearest 1 kg/m ³)		
	PTA 3	Z-Score	
1	2373	-0.51	
2	2368	-0.93	
3	2366	-1.10	
4	2383	0.34	
5	2378	-0.08	
6	2363	-1.35	
7	2379	0.00	
8	2383	0.34	
9	2372	-0.59	
10	2412	2.78	?
11	2389	0.84	
12	2403	2.02	?
13	2371	-0.67	
14	2400	1.77	
15	2375	-0.34	
16	2378	-0.08	
17	2375	-0.34	
18	2368	-0.93	
19	2389	0.84	
20	2383	0.34	
21	2382	0.25	
22	2392	1.10	
23	2368	-0.93	
24	2364	-1.26	
25	2373	-0.51	
26	2400	1.77	
27	2379	0.00	
28	2388	0.76	
29	2383	0.34	
30	2409	2.53	?
31	2383	0.34	

No. of Results	31
Median	2379.0
Normalised IQR	11.9
Uncertainty of the Median	2.7
Robust CV	0.5%
Minimum	2363
Maximum	2412
Range	49



Lab Code	Mass/Volume (Nearest 1 kg/m ³)		
	PTA 4	Z-Score	
1	2409	0.54	
2	2394	-1.48	
3	2409	0.54	
4	2413	1.08	
5	2410	0.67	
6	2390	-2.02	?
7	2395	-1.35	
8	2422	2.29	?
9	2408	0.40	
10	2445	5.40	§
11	2405	0.00	
12	2384	-2.83	?
13	2403	-0.27	
14	2420	2.02	?
15	2409	0.54	
16	2400	-0.67	
17	2368	-4.99	§
18	2402	-0.40	
19	2411	0.81	
20	2409	0.54	
21	2413	1.08	
22	2416	1.48	
23	2405	0.00	
24	2392	-1.75	
25	2407	0.27	
26	2401	-0.54	
27	2401	-0.54	
28	2422	2.29	?
29	2401	-0.54	
30	2376	-3.91	§
31	2405	0.00	

No. of Results	31
Median	2405.0
Normalised IQR	7.4
Uncertainty of the Median	1.7
Robust CV	0.3%
Minimum	2368
Maximum	2445
Range	77



Lab Code	Compressive Strength (Nearest 0.1 MPa)		
	PTA 3	Z-Score	
1	44.3	-2.48	?
2	50.9	-0.14	
3	54	0.96	
4	41.5	-3.47	§
5	54	0.96	
6	51.1	-0.07	
7	52.7	0.50	
8	48.5	-0.99	
9	54.4	1.10	
10	43.3	-2.84	?
11	51.3	0.00	
12	44.8	-2.30	?
13	54.2	1.03	
14	55	1.31	
15	52.9	0.57	
16	46	-1.88	
17	49.9	-0.50	
18	11.5	-14.11	§
19	52	0.25	
20	54.2	1.03	
21	52.7	0.50	
22	52.1	0.28	
23	57.5	2.20	?
24	50.8	-0.18	
25	52.7	0.50	
26	38.8	-4.43	§
27	40.5	-3.83	§
28	50.3	-0.35	
29	53.6	0.82	
30	48.1	-1.13	
31	55.4	1.45	

Lab Code	Compressive Strength (Nearest 0.1 MPa)		
	PTA 4	Z-Score	
1	43.4	-2.08	?
2	49	0.00	
3	50.8	0.67	
4	36.5	-4.64	§
5	48.6	-0.15	
6	47.9	-0.41	
7	50.5	0.56	
8	43.5	-2.04	?
9	49.2	0.07	
10	43.3	-2.12	?
11	50.8	0.67	
12	40.8	-3.04	§
13	49.8	0.30	
14	51.5	0.93	
15	48.7	-0.11	
16	42.3	-2.49	?
17	50.2	0.45	
18	42.4	-2.45	?
19	49.1	0.04	
20	51.2	0.82	
21	48.1	-0.33	
22	50.5	0.56	
23	53.5	1.67	
24	47	-0.74	
25	51	0.74	
26	42.7	-2.34	?
27	41.2	-2.89	?
28	46.4	-0.96	
29	50	0.37	
30	53.9	1.82	
31	51.8	1.04	

Summary Statistics

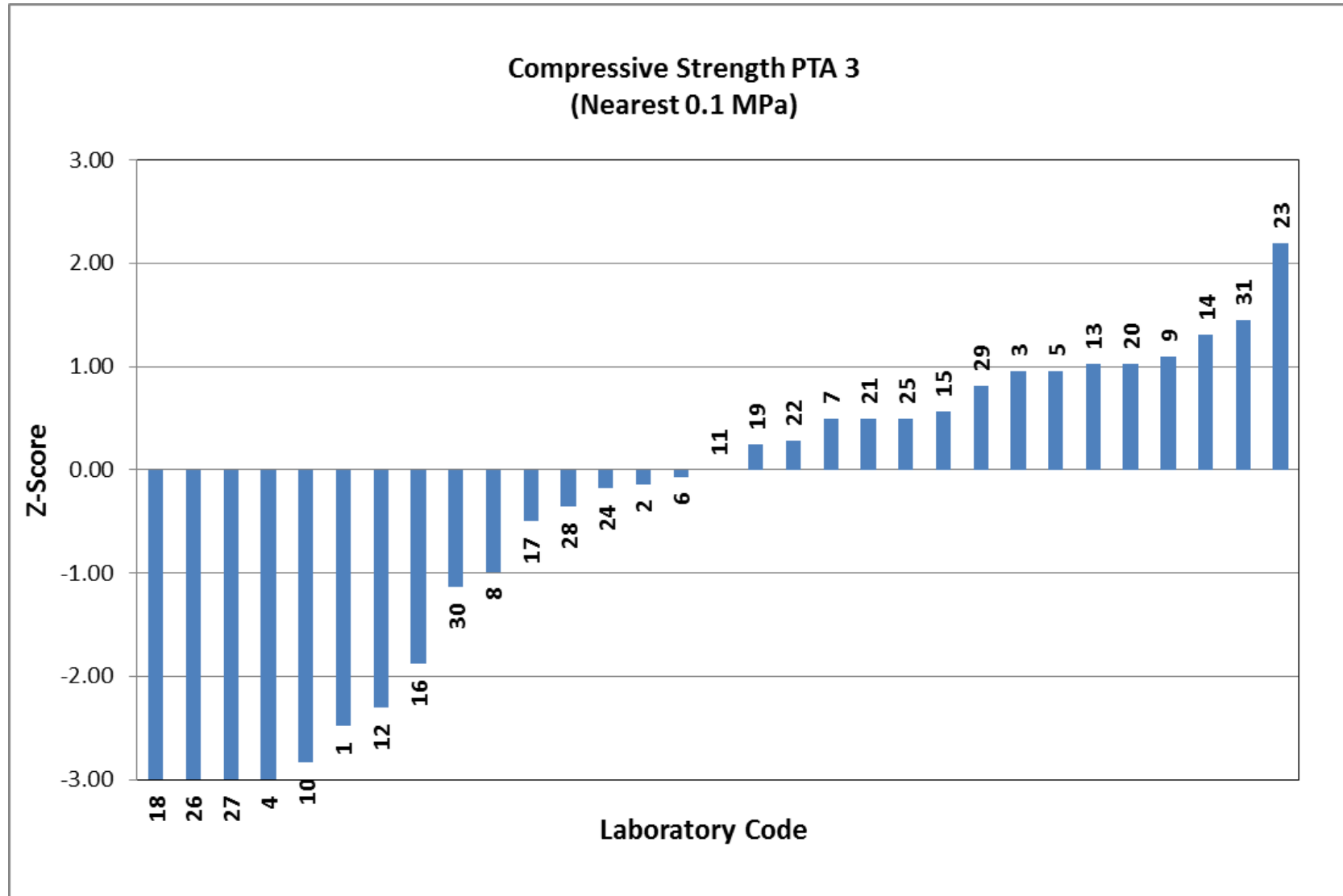
Compressive Strength	PTA 3	PTA 4
No. of Results	31	31
Median	51.30	49.00
Normalised IQR	5.00	5.34
Uncertainty of the Median	1.13	1.20
Robust CV	9.8%	10.9%
Target SD	2.82	2.70
Target CV	5.5%	5.5%
Minimum	11.5	36.5
Maximum	57.5	53.9
Range	46	17.4

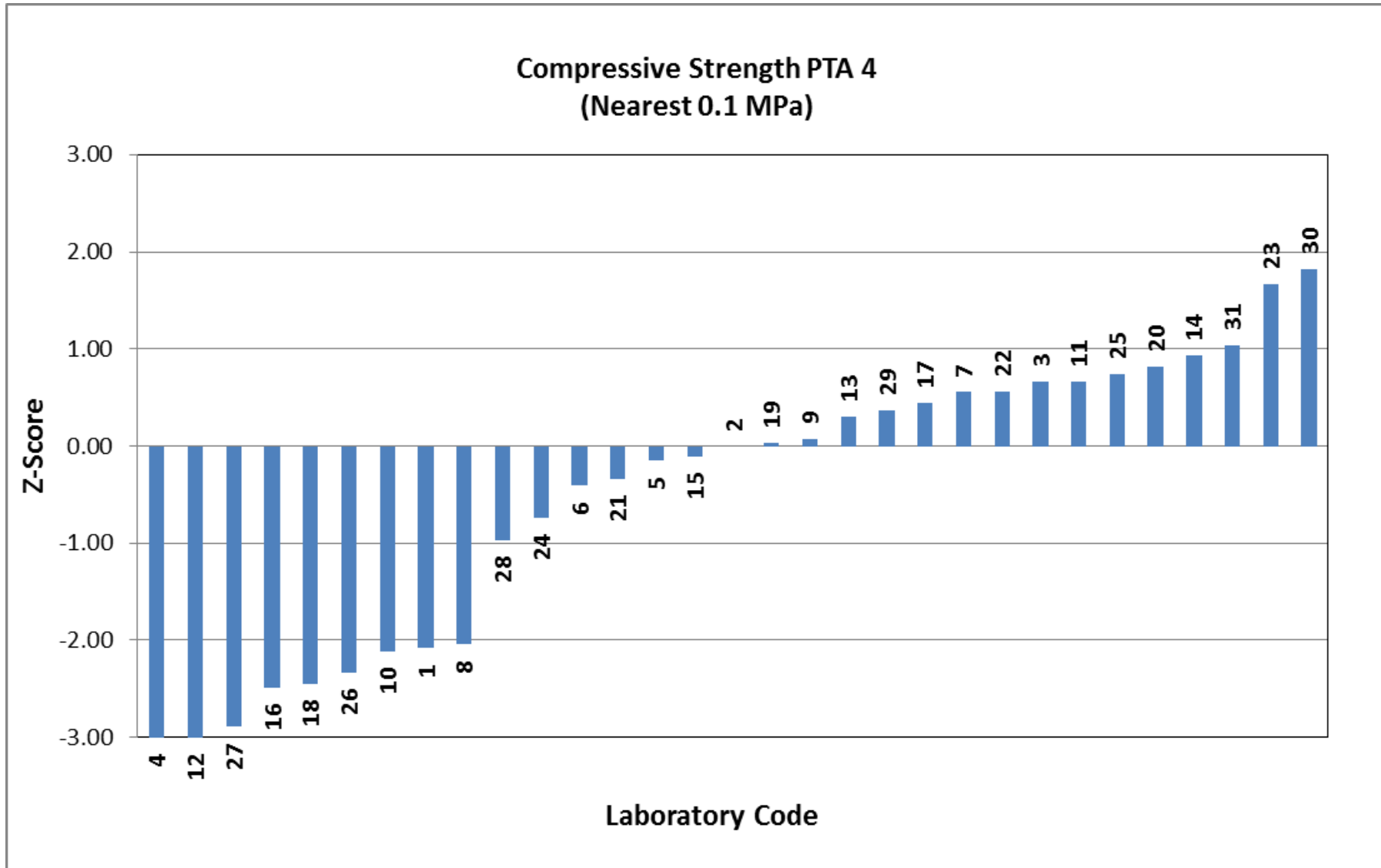
Please note that the target CV was used to calculate the z-scores.

Notes that apply to the tables on pages A5, A7 and A9:

"?" 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	Failure Mode		Date of Receipt	Date of Tests
	PTA 3	PTA 4		
1	10% Cone	10% Cone	13/04/2018	20/04/2018
2	Normal	Normal	11/04/2018	20/04/2018
3	N	N.	9/04/2018	20/04/2018
4	Satisfactory	Satisfactory	12/04/2018	20/04/2018
5	Normal	Normal	18/04/2018	20/04/2018
6	5	5	11/04/2018	19/04/2018
7	Standard Shear	Standard Shear	18/04/2018	20/04/2018
8	N	N	16/04/2018	20/04/2018
9	Normal	Normal	20/04/2018	20/04/2018
10	Side fracture at top (Type 5)	Side fracture at top (Type 5)	10/04/2018	20/04/2018
11	N	N	18/04/2018	20/04/2018
12	3	3	15/04/2018	19/04/2018
13	3	4	12/04/2018	19/04/2018
14	Shear	Shear	18/04/2018	20/04/2018
15	L (Cone shear)	Shear (S)	16/04/2018	20/04/2018
16	4	4	12/04/2018	20/04/2018
17	Normal	Normal	11/04/2018	20/04/2018
18	Side fracture at bottom	Well-formed cone on one end with vertical cracks running through caps	12/04/2018	19/04/2018
19	Standard shear	Standard shear	16/04/2018	20/04/2018
20	S	S.	9/04/2018	20/04/2018
21	Satisfactory (S)	Satisfactory (S)	11/04/2018	20/04/2018
22	Vertical splitting	Vertical splitting	16/04/2018	20/04/2018
23	N	S	24/04/2018	24/04/2018
24	Columnar cracking	Columnar cracking	14/04/2018	20/04/2018
25	Type 3	Type 3	12/04/2018	20/04/2018
26	Normal	Shear	10/04/2018	20/04/2018
27	3	3	12/04/2018	19/04/2018
28	Vertical splitting	Vertical splitting	16/04/2018	20/04/2018
29	Sheared	Sheared	10/04/2018	20/04/2018
30	Cone shear (L)	Normal (N)	16/04/2018	20/04/2018
31	Normal	Normal	10/04/2018	20/04/2018

Lab Code	Moisture Condition	Average Temperature Curing Tank	End Treatment	Method
1	Moist	27.5°C	Sulphur cap	AS 1012.9.1
2	SSD	23-25°C	End ground	AS 1012.9, AS 1012.12.1
3	SSD	27°C	Ground	AS 1012.9
4	SSD-PTA 3, Dry-PTA 4	24.9°C	Sandbox Method using fine siliceous sand	BS EC-12390.3
5	SSD	23.0°C	Ground	AS 1012.12.1, AS 1012.9
6	SSD	23°C	19.04.2018	ASTM C-39
7	SSD	27°C	Rubber capping	AS 1012
8	SSD	26°C	Sulphur cap	1012.9
9	SSD	27°C	Rubber cap	1012.9
10	SSD	20°C	Capping (ASTM C617/ C617 M-2015)	ASTM C39/C39M-18
11	SSD	23°C	Ground	AS 1012.12.1, AS 1012.9
12	SSD	23°C	#	ASTM C-617 and C-39
13	SSD	23°C	ASTM C617 (Sulphur capping)	ASTM C39
14	SSD	27.4°C	Rubber capping	AS 1012
15	SSD	22.5°C	End ground	AS 1012.9
16	SSD	23°C	Sulfur mortar capping	ASTM C 617 and ASTM C 39
17	SSD	23-25°C	End ground	AS 1012.9, AS1012.12.1
18	SSD	21°C	Sulfur capping	ASTM C39
19	SSD	27°C	Rubber capping	AS 1012
20	SSD	27°C	Rubber cap	AS 1012
21	SSD	19.2°C	Cupping (one end)	EN 12390.1/ EN 12390-3/ EN 12390-7
22	SSD	23.0°C	Ground	AS 1012.9
23	SSD	26°C	Rubber	AS 1012
24	SSD	23°C	Ground	AS 1012
25	SSD	20.1°C	Sulphur capping	ASTM C39 M-17a
26	SSD	27.4°C	Sulphur capped	AS 1012
27	SSD	23°C	#	ASTM C-617 and C-39
28	SSD	23.0°C	Ground	AS 1012.9
29	SSD	23°C	Rubber capping	AS 1012.9
30	SSD	22.5°C	End ground	AS 1012.9
31	SSD	23°C	Restrained natural rubber capping system	AS 1012.9

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 24 Homogeneity Results										
PTA 3										
Sample Number	Date Sampled	Date Tested	Height (mm)	Average Diameter (mm)	Weight	Mass per Unit Volume (kg/m ³)	Compressive Strength (Mpa)	Age of Specimen (Days)	Capping Method	Condition of Specimen
6	6/03/2018	20/04/2018	199	100.2	3728	2376	53.7	45 days	Rubber	SSD
8	6/03/2018	20/04/2018	200	100	3751	2388	49.8	45 days	Rubber	SSD
17	6/03/2018	20/04/2018	200	100.2	3757	2387	49.8	45 days	Rubber	SSD
18	6/03/2018	20/04/2018	200	100.2	3756	2382	51.3	45 days	Rubber	SSD
27	6/03/2018	20/04/2018	200	100.2	3746	2375	53.7	45 days	Rubber	SSD
30	6/03/2018	20/04/2018	200	100.2	3744	2374	52.8	45 days	Rubber	SSD
35	6/03/2018	20/04/2018	199	100.2	3732	2378	53.2	45 days	Rubber	SSD
36	6/03/2018	20/04/2018	199	100.2	3731	2378	51.2	45 days	Rubber	SSD
Mean			199.63	100.18	3743.13	2379.75	51.94			
Standard Deviation			0.52	0.07	11.52	5.37	1.63			
Coefficient of Variation			0.26%	0.07%	0.31%	0.23%	3.14%			
Lowest Value			199	100	3728	2374	49.8			
Highest Value			200	100.2	3757	2388	53.7			

Concrete Round 24 Homogeneity Results										
PTA 4										
Sample Number	Date Sampled	Date Tested	Height (mm)	Average Diameter (mm)	Weight	Mass per Unit Volume (kg/m ³)	Compressive Strength (Mpa)	Age of Specimen (Days)	Capping Method	Condition of Specimen
2	7/03/2018	20/04/2018	200	100.2	3795	2411	49.2	44 days	Rubber	SSD
8	7/03/2018	20/04/2018	200	100.2	3781	2398	50.4	44 days	Rubber	SSD
13	7/03/2018	20/04/2018	200	100.2	3792	2404	50.6	44 days	Rubber	SSD
19	7/03/2018	20/04/2018	200	100.2	3794	2406	50.4	44 days	Rubber	SSD
20	7/03/2018	20/04/2018	200	100	3787	2406	52.5	44 days	Rubber	SSD
28	7/03/2018	20/04/2018	200	100.2	3798	2408	52.3	44 days	Rubber	SSD
35	7/03/2018	20/04/2018	201	100.2	3800	2398	49	44 days	Rubber	SSD
37	7/03/2018	20/04/2018	200	100.2	3802	2411	48.1	44 days	Rubber	SSD
Mean			200.13	100.18	3793.63	2405.25	50.31			
Standard Deviation			0.35	0.07	6.95	5.09	1.54			
Coefficient of Variation			0.18%	0.07%	0.18%	0.21%	3.07%			
Lowest Value			200	100	3781	2398	48.1			
Highest Value			201	100.2	3802	2411	52.5			

APPENDIX C

Documentation

Instructions to Participants	C1
Results Sheet	C3

PROFICIENCY TESTING AUSTRALIA
Proficiency Testing Program
Concrete Round 24

INSTRUCTIONS TO PARTICIPANTS

PLEASE NOTE CYLINDERS ARE TO BE TESTED ON THE 20 APRIL.

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 3 and PTA 4.
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/m³

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 (°C) of the curing tank water until tested.
7. Remove and test the cylinders marked PTA 3 and PTA 4 on **20 April**.
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/m³.
 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 **27 April** to:

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

PROFICIENCY TESTING AUSTRALIA
Concrete 24 - Proficiency Testing Program
Results Sheet

TEST DATE: 20 April 2018
Lab Code:

NOTE: When entering results, please ensure that the measurement recorded corresponds to the cylinder PTA 3 or PTA 4.

TEST (report to)	PTA 3	PTA 4
Height (nearest 1 mm)		
Diameter (nearest 0.2 mm)		
Weight (nearest 1g)		
Mass/Volume (nearest 1 kg/m ³)		
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 3 & PTA 4: _____ Signature: _____

 Return no later than **Friday 27 April** to:

Emilia Cincu
Proficiency Testing Australia
Phone: 02 9736 8397
Fax: 02 9743 6664
Email: emilia.cincu@pta.asn.au

- End of Report -