



APLAC T031

Final Report

Cement Proficiency Testing (Compressive Strength)

July 2010

APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

– TABLE OF CONTENTS –

1. INTRODUCTION	3
2. OPERATION OF THE PROGRAM	3
2.1 COORDINATING BODY	3
2.2 RELATED ORGANISATION	3
2.3 LABORATORIES PARTICIPATED IN THE APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM	4
2.4 THE DATES OF OPERATION OF THE PROGRAM	4
3. CONTENT OF APPENDICIES	5
4. STATISTICAL DESIGN OF THE PROGRAM	5
4.1 STATISTICAL ANALYSIS	5
4.2 EVALUATION CRITERIA	6
5. TEST SAMPLES	6
5.1 SAMPLE COMPOSITION	6
5.2 HOMOGENEITY TEST	6
6. TEST METHOD	6
7. REPORTED RESULTS	7
8. ANALYSIS OF THE RESULTS	7
8.1 SUMMARY STATISTICS	7
8.2 PERFORMANCE OF LABORATORIES	8
8.3 OUTLIER RESULTS	8
9. TECHNICAL COMMENTS:	8
9.1 SAMPLE HOMOGENEITY	8
9.2 COMMENTS ON REPORTED RESULTS	9
9.3 DATA REPORTED BY LAB No.48	9
9.4 PREPARATION AND CURING OF SPECIMEN, AND TEST CONDITIONS	9
9.5 MODIFICATION OF ISO 679	10
APPENDIX A TEST RESULTS - COMPRESSIVE STRENGTH	11
APPENDIX B TEST SPECIMEN	25
APPENDIX C HOMOGENEITY TEST RESULTS	26
APPENDIX D INSTRUCTIONS TO PARTICIPANTS	29

1. INTRODUCTION

This report summarizes the results of the APLAC Cement Proficiency Testing Program (APLAC T031).

The APLAC T031 was coordinated by the International Accreditation Japan (hereinafter referred to as “IAJapan”, former Japan National Laboratory Accreditation System (hereinafter referred to as “JNLA”), Conformity Assessment Center), National Institute of Technology and Evaluation (hereinafter referred to as “NITE”) in accordance with the interlaboratory testing scheme specified in ISO/IEC Guide 43-1:1997 (See Note for section 2.1).

The aim of this proficiency testing program was to provide opportunity to participating laboratories to demonstrate their technical competence to perform applicable/relevant tests. It also provides confidence in the accreditation process of the APLAC members and also in their ability to take an appropriate corrective action where a result of this PT program reveals testing deficiencies in the laboratory.

2. OPERATION OF THE PROGRAM

2.1 COORDINATING BODY

JNLA, Conformity Assessment Center, NITE
2-49-10, Nishihara, Shibuya-ku, Tokyo, 151-0066, JAPAN
TEL: +81-3-3481-1939
FAX: +81-3-3481-1937

Note: JNLA has started its operation under IAJapan since 2002.

2.2 RELATED ORGANISATION

The organization for implementing the homogeneity testing of test pieces for this proficiency testing program was:

General Building Research Corporation of Japan
5-8-1, Fujishirodai, Suita, Osaka, 565-0873, JAPAN
TEL: +81-6-6834-7916
FAX: +81-6-6872-0391

2.3 LABORATORIES PARTICIPATED IN THE APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

84 laboratories from 27 economies had been nominated to participate in this proficiency testing program. 20 laboratories among participated laboratories did not report the results of the test with various reasons. Details of actual participating laboratories are shown in the Table 1.

Table 1 Number of participating laboratories per economy

Economy	No. of Labs	Economy	No. of Labs	Economy	No. of Labs
Australia	2	Germany	2	Philippines	3
Brazil	1	Hong Kong	3	Portugal	2
Brunei	3	India	3	Slovakia	2
Bulgaria	3	Japan	11	Slovenia	1
China	3	Korea	1	South Africa	3
Croatia	2	Latvia	1	Spain	1
Estonia	1	Lithuania	2	Switzerland	1
Finland	2	Malaysia	1	Thailand	3
France	2	Norway	1	Vietnam	4

2.4 THE DATES OF OPERATION OF THE PROGRAM

The program was started in 2002. Participating laboratories and/or accreditation bodies already received the interim report in 2002, but the final report has been delayed for approximately 8 years. Following Table 2 is the dates of operation of the program.

Table 2 Date of Operation of the program

Preparation of sample	Oct 2001
Submission of proposal to APLAC PT Committee for approval	Nov 2001
Invitation to participants	Dec 2001
Dispatch of samples	Jan 2002 - Feb 2002
Compressive strength testing by participants	Feb 2002 - Mar 2002
Homogeneity testing by related organization	Feb 2002 - Mar 2002
Deadline for result submission from participants	30 Apr 2002
Statistical analysis	Jun 2002
Distribution of Interim report	Jun 2002 - Jul 2002
Statistical analysis for the second time	Till May 2010
Preparation of draft final report	May 2010
Submission of draft final report to APLAC PT Committee for approval	Jun 2010
Distribution of final report	Jul 2010

3. CONTENT OF APPENDICIES

APPENDIX A: TEST RESULTS - COMPRESSIVE STRENGTH

Table A.1 Compressive Strength Test - Sample A (specimen age: 7 days)

Fig 1 Histogram of Compressive Strength Test Results - Sample A

Table A.2 Compressive Strength Test - Sample B (specimen age: 28 days)

Fig 2 Histogram of Compressive Strength Test Results - Sample B

Table A.3 z -scores for Individual Samples, Between Laboratories and Within Laboratory

Fig 3 z -score Distribution - Sample A

Fig 4 z -score Distribution - Sample B

Fig 5 z -score Distribution - Between Laboratories z -score (ZB)

Fig 6 z -score Distribution - Within Laboratory z -score (ZW)

Fig 7 Youden Plot - APLAC T031 Cement

APPENDIX B: TEST SPECIMEN

APPENDIX C: HOMOGENEITY TEST RESULTS

APPENDIX D: INSTRUCTIONS TO PARTICIPANTS

4. STATISTICAL DESIGN OF THE PROGRAM

A split level statistical design was used for this program. The samples at ages 7 days and 28 days were subject to this program. The difference of the crushing load planned for these two samples was approximately 20 N/mm² which meant around 40 % of the strength of the sample at age 7 days.

4.1 STATISTICAL ANALYSIS

The data submitted by the participating laboratories were analyzed by mean of the z -score specified in ISO/IEC Guide 43-1, Appendix A, *Statistical methods for treatment of the proficiency test data*, A.2.1.4. For this proficiency testing program, a robust statistics by using the median and Normalized Inter Quartile Range (NIQR) to minimize the influence of extreme data was adopted.

For each participating laboratory, the z -score for each sample was calculated. In addition, the between-laboratories z -score (ZB) and the within-laboratory z -score (ZW) were calculated for the sample pair. The between-laboratories z -score was based on the (standardised) sum of the calculated mean of the duplicate results reported for each sample. The within laboratory z -score was based on the (standardised) difference between the mean of the duplicate results reported for each sample.

4.2 EVALUATION CRITERIA

The evaluation criteria by means of z-score in accordance with the ISO/IEC Guide 43-1 Appendix A were used. The followings are the criteria for “Satisfactory”, “Questionable” and “Unsatisfactory”:

$|z| \leq 2$: Satisfactory,
 $2 < |z| < 3$: Questionable, and
 $|z| \geq 3$: Unsatisfactory

5. TEST SAMPLES

5.1 SAMPLE COMPOSITION

One set of the test sample consists of standard cement (2 kg × 1 bag) and standard sand (1 350 g × 2 bags). This set was distributed to each laboratory (see Appendix B).

5.2 HOMOGENEITY TEST

One hundred sets of the test sample (materials for test specimen) were prepared for this proficiency testing program. Prior to the distribution of samples, six sets (sample code: A to F) of 100 were randomly picked up and homogeneity test pieces were prepared in accordance with the method specified in ISO 679:1989. The homogeneity test samples for compression test were placed and molded by one mixing.

As for the homogeneity test, the compressive strength of the homogeneity test samples was measured in accordance with ISO 679. The test samples at ages 7 days and 28 days were tested. The homogeneity test samples were cultivated before the test in accordance with the method specified in ISO 679.

The Appendix B shows the details of the homogeneity test.

6. TEST METHOD

The proficiency test samples and the instructions were sent to all participating laboratories. Participating laboratories were instructed to form the test specimen and perform the compression test on the samples at ages 7 days and 28 days in accordance with ISO 679 or equivalent regional/national standard.

The participating laboratories were also instructed to report the test results in the form of the results sheet shown in the procedures (See Appendix C).

7. REPORTED RESULTS

Table A.1 and A.2 show the reported test results for samples at ages 7 days and 28 days respectively and their calculated averages. The summary statistics of those samples with the histogram of the reported data were also shown in these appendices.

A unique code number for this program was randomly allocated to each participating laboratory which enables to keep confidentiality of results. Reference to each participating laboratory in this report is made by its assigned code number.

Table A.3 shows the z -scores for each test sample. It also provides between laboratories z -score and within laboratory z -score with support of Table 3 for the cause analysis and consideration of the remedial actions for outlier results (See 8.3).

8. ANALYSIS OF THE RESULTS

8.1 SUMMARY STATISTICS

Following Table 3 is the summary statistics for calculation of z -scores of the test results.

Table 3 Summary Statistics

Items	Summary statistics			
	Sample A age: 7 days	Sample B age: 28 days	Inter- Laboratories	Intra- Laboratories
Number of Results	64	64	64	64
Median	45.4	62.1	76.6	11.4
Minimum Value	27.2	36.1	44.7	-23.3
Maximum Value	87.9	68.8	101.0	16.6
Range	60.8	32.7	56.3	39.9
Robust CV (%)*	7.38	9.91	8.68	20.5
First Quartile	43.1	56.3	70.2	9.30
Third Quartile	47.6	64.6	79.2	12.47
Inter Quartile range	4.52	8.30	8.96	3.17
Normalized Inter Quartile Range (NIQR)	3.35	6.16	6.64	2.35

* Robust CV (%): Robust Coefficient of Variation

8.2 PERFORMANCE OF LABORATORIES

As mentioned in the Section 4, z -score was used as a performance statistic of the results and then the criteria in 4.2 were applied for performance evaluation. Table A.3 shows the summary of the performance evaluation. Between laboratories z -score (ZB) and within laboratory z -score (ZW) are also calculated for the two (7 days and 28 days) test specimens for consideration of the trend analysis in measurement. The z -score of each sample, between laboratories z -score (ZB) and within laboratory z -score (ZW) are strongly correlated to each other, therefore, z -score of each sample is representatively used in the performance evaluation of participating laboratories data.

8.3 OUTLIER RESULTS

The laboratories that were categorized as “Unsatisfactory (z -score ≥ 3)” in the compression tests are shown in the Table 4.

Table 4 Outlier Results

Items for z -score evaluation	Laboratory Code No.
Sample A (Specimen age: 7 days)	8, 10, 29, 30, 31, 48, 49, 51
Sample B (Specimen age: 28 days)	29, 30, 31
Between laboratories z -score (ZB)	10, 29, 30, 31, 48, 49
Within laboratory z -score (ZW)	48

Of the 64 participating laboratories, the total of 8 (12.5 %) laboratories has been identified as having reported one or more outlying results. Out of 256 results subject to the z -score evaluation, the total 18 results (7.0 %) have been identified as outlier.

9. TECHNICAL COMMENTS

9.1 SAMPLE HOMOGENEITY

As shown in the Appendix B, the standard deviations (7 days specimen: 0.50 N/mm^2 , 28 days specimen: 0.43 N/mm^2) of the results in the homogeneity testing were well smaller than those (7 days specimen: 3.35 N/mm^2 , 28 days specimen: 6.16 N/mm^2) of results reported by participating laboratories ($\text{STD} < 0.3 \text{ IQR}$). Therefore, it was concluded that the samples distributed were sufficiently homogeneous.

9.2 COMMENTS ON REPORTED RESULTS

45 of 64 participating laboratories (approximately 70 %) reported that they had performed test in accordance with ISO 679:1989. Remaining 19 of 64 laboratories (approximately 30 %) performed tests based on the regional or national standard such as AS 2350, BS 186-1, BS 4550, TCVN, EN 196-1, JIS, GB/T 17671, ASTM C 109. Basically, those regional/national standards are considered that they are in line with ISO 679. The test results agree well, and there is no significant difference of the results among standards was observed. However, laboratories code **7, 8, 18, 29, 31** reported only 2 or 3 results while ISO 679 specifies 6 results to be measured (see NOTE) and they were all based on the national standards. Considering that laboratories code 8, 29 and 31 had outlier results in the program, difference of the test standard might cause the deviation of the results.

NOTE: ISO 679, 10.2 specifies “A test result is defended as the arithmetic mean of the six compressive strength determinations made on a set of three prisms. If one result within the six determinations varies by more than $\pm 10\%$ from the mean of the 6, discard this result and calculate the mean of the five remaining result. If a further result which in these five determinations varies by more than $\pm 10\%$ from the mean, discard the set of result”. These 5 laboratories calculated averages from 2 or 3 compressive strength determinations, and did not treat varies in accordance with the ISO 679.

9.3 DATA REPORTED BY LAB No.48

As shown in the table 1 above, the average of crushing strengths of the specimen at age 7 days and 28 days were 46.2 N/mm^2 and 63.5 N/mm^2 respectively, i.e., the crushing strength of 28 days sample is around 37 % (average) larger than that of 7 day sample. However, Lab.48 reported that the crushing load of 7 days sample and 28 days sample were 87.9 N/mm^2 and 55.0 N/mm^2 (average) respectively. This might be caused by one or more failures or different conditions in the process of the test. Possible causes are failure in specimen identification, miscalculation in data transformation, difference of test conditions and/or failures in preparation of test specimen.

9.4 PREPARATION AND CURING OF SPECIMEN, AND TEST CONDITIONS

ISO 679 specifies that “the laboratory where preparation of specimens takes place shall be maintained at a temperature of $20^\circ\text{C} \pm 2^\circ\text{C}$ and relative humidity of not less than 50 %”, “the moist air room or the large cabinet for storage shall be maintained at a temperature of $20^\circ\text{C} \pm 1^\circ\text{C}$ and a relative humidity of not less than 90 %”, “the temperature of the water in the storage containers shall be maintained at $20^\circ\text{C} \pm 1^\circ\text{C}$ ”, “in warm countries, a laboratory temperature of $25^\circ\text{C} \pm 2^\circ\text{C}$ or $25^\circ\text{C} \pm 2^\circ\text{C}$ may be maintained, temperature of the moist air room or the cabinet for storage and temperature if the water in

APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

the storage container may be maintained at $25\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ or $27\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ". The following laboratories reported that they performed test with room conditions that were deviated from those specified in ISO 679.

Table 5 Laboratories that adopted test conditions other than those specified in ISO 679

Room Conditions	Codes of Lab that performed test under room conditions other than those specified in ISO 679
Test specimen preparation: temperature ($20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$)	7, 8, 24
Test specimen preparation: humidity ($< 50\%$)	10, 24
Laboratory temperature: $20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ or $27\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ in warm countries)	
Moist air room / cabinet: temperature ($20\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$)	2, 7, 8, 24, 29, 31, 34, 35, 37, 38, 50, 52
Moist air room / cabinet: Humidity ($< 90\%$)	7, 8, 10, 24, 29, 54, 58
Water temperature in storage containers: Specimen age: 7 days	2, 10, 24, 29, 30, 31, 34, 35, 36, 37
Water temperature in storage containers: Specimen age: 28 days	2, 10, 19, 24, 29, 30, 31, 34, 35, 36, 37

9.5 MODIFICATION OF ISO 679

ISO 679 was modified in May, 2009. There are many alternations in the standard from last edition. However, main contents of the standard which effect for test results (e.g. environmental testing condition, specification of equipment, preparation of mortar, condition and preparation of test specimens, testing procedures, and calculation equation) have no change or a few revisions.

Therefore, if someone will coordinate the same proficiency testing program in 2010, the participating laboratories will submit the reporting results which are almost all same with the results of this proficiency testing program.

APPENDIX A TEST RESULTS - COMPRESSIVE STRENGTH**Table A.1 Compressive Strength Test - Sample A (specimen age: 7 days)**

Lab code	Crushing load (N/mm ²)						Mean
	1	2	3	4	5	6	
1	46.9	48.3	48.0	45.7	47.8	47.4	47.4
2	47.9	48.4	48.2	48.9	47.4	47.6	48.1
3	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–
5	49.7	51.5	51.6	52.1	52.8	52.9	51.8
6	–	–	–	–	–	–	–
7	47.0	46.0	–	–	–	–	46.5
8	21.2	46.5	–	–	–	–	33.9
9	–	–	–	–	–	–	–
10	28.8	30.0	31.5	32.3	33.7	33.2	31.6
11	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–
13	–	–	–	–	–	–	–
14	45.3	45.3	43.0	42.9	43.1	44.1	44.0
15	43.9	43.5	44.4	44.1	43.7	43.4	43.8
16	–	–	–	–	–	–	–
17	55.4	58.3	54.1	53.4	54.2	54.7	55.0
18	39.7	40.5	40.1	–	–	–	40.1
19	40.6	41.9	39.7	42.2	40.0	42.2	41.1
20	46.6	47.2	46.4	46.4	45.6	47.2	46.6
21	–	–	–	–	–	–	–
22	47.1	47.2	43.8	41.9	47.1	49.9	46.2
23	–	–	–	–	–	–	–
24	44.9	43.5	43.8	43.3	44.3	43.4	43.9
25	57.2	56.6	52.4	53.0	52.9	53.1	54.2
26	43.1	43.6	43.8	44.8	44.5	44.6	44.1
27	45.3	44.7	45.2	45.0	45.0	43.4	44.8
28	–	–	–	–	–	–	–
29	27.0	30.0	28.0	–	–	–	28.3
30	30.5	29.6	30.1	30.3	29.3	29.8	29.9
31	26.7	28.6	26.2	–	–	–	27.2
32	–	–	–	–	–	–	–
33	–	–	–	–	–	–	–
34	41.9	43.9	41.8	44.7	43.1	43.4	43.1

APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

35	47.4	47.7	47.6	48.4	46.3	48.1	47.6
36	46.4	47.3	47.0	47.3	47.8	46.7	47.1
37	45.9	47.6	47.1	47.8	47.8	46.5	47.1
38	44.1	45.2	45.0	43.9	44.3	45.9	44.7
39	43.6	42.3	42.4	42.5	42.3	42.6	42.6
40	–	–	–	–	–	–	–
41	–	–	–	–	–	–	–
42	–	–	–	–	–	–	–
43	–	–	–	–	–	–	–
44	–	–	–	–	–	–	–
45	39.2	40.2	40.4	40.9	39.3	39.0	39.8
46	40.8	40.0	40.4	42.7	42.7	41.3	41.3
47	45.1	45.7	46.2	46.8	45.0	43.8	45.4
48	88.0	88.5	87.5	88.0	87.0	88.5	87.9
49	31.6	35.6	33.4	33.8	35.6	33.8	34.0
50	35.6	38.7	35.1	38.4	31.1	33.2	35.4
51	35.9	34.1	34.6	36.8	34.3	32.2	34.7
52	44.7	44.1	45.9	45.0	44.4	44.1	44.7
53	50.3	53.5	49.5	53.6	53.0	51.3	51.9
54	44.9	43.4	43.3	43.3	44.7	43.4	43.8
55	44.4	45.8	43.4	44.1	45.0	44.4	44.5
56	48.8	48.1	45.6	49.7	48.6	46.6	47.9
57	43.6	44.2	43.2	45.0	44.3	42.6	43.8
58	48.6	48.4	46.3	47.5	48.2	47.0	47.7
59	42.8	43.4	42.2	42.8	43.1	43.4	43.0
60	46.1	44.5	45.0	44.3	46.4	45.8	45.4
61	44.0	42.8	44.8	43.3	45.0	43.7	43.9
62	50.3	49.2	51.0	50.7	50.3	49.9	50.2
63	51.0	51.0	49.0	51.3	48.6	49.2	50.0
64	42.8	43.1	44.2	43.6	42.3	42.8	43.1
65	41.2	42.6	43.0	44.8	41.6	42.4	42.6
66	50.0	49.3	49.1	48.5	48.9	49.2	49.2
67	49.1	50.0	49.6	49.8	49.6	49.2	49.6
68	49.7	49.4	47.4	49.3	50.3	48.9	49.2
69	–	–	–	–	–	–	–
70	49.2	47.8	49.9	48.0	49.2	47.8	48.7
71	–	–	–	–	–	–	–
72	51.0	53.2	50.4	51.9	50.8	51.6	51.5
73	50.2	50.6	52.1	49.8	49.0	49.6	50.2
74	45.6	45.4	45.2	45.6	45.6	45.1	45.4

APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

75	45.6	45.7	46.9	46.4	46.2	46.6	46.2
76	45.5	45.6	45.9	46.2	46.1	46.2	45.9
77	48.6	47.2	47.9	47.0	46.0	46.9	47.3
78	46.0	45.6	45.5	45.9	44.6	44.6	45.4
79	47.3	46.3	46.4	46.8	47.7	46.3	46.8
80	47.2	45.8	46.6	46.3	46.1	46.4	46.4
81	41.4	43.3	42.4	43.1	42.3	43.0	42.6
82	47.4	46.2	48.2	48.7	47.6	47.4	47.6
83	45.6	43.4	45.9	45.0	44.7	46.1	45.1
84	46.1	45.2	45.0	44.5	45.3	44.4	45.1

Number of Results	64
Median	45.4
Minimum Data	27.2
Maximum Data	87.9
Range	60.8
Robust CV (%)	7.38
First Quartile	43.1
Third Quartile	47.6
Inter Quartile Range	4.52
Normalized IQR	3.35

Fig 1 Histogram of Compressive Strength Test Results - Sample A

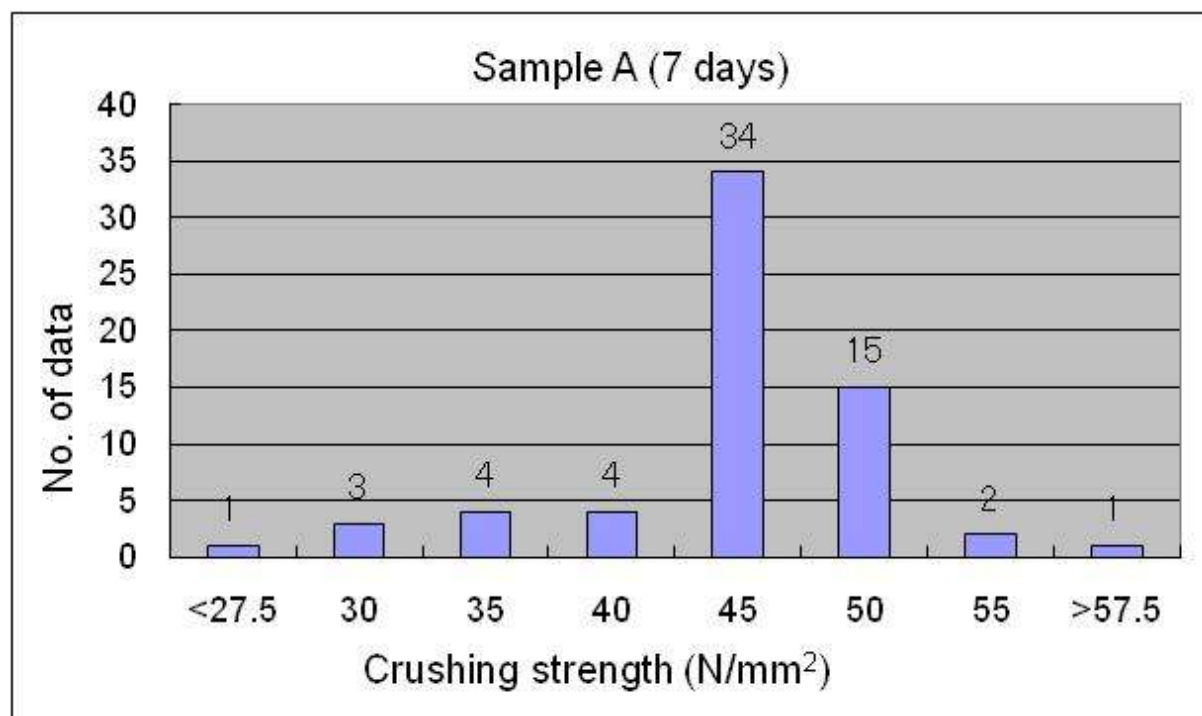


Table A.2 Compressive Strength Test - Sample B (specimen age: 28 days)

Lab code	Crushing load (N/mm ²)						Mean
	1	2	3	4	5	6	
1	63.8	64.2	63.6	63.7	65.4	63.3	64.0
2	64.4	60.4	65.1	64.3	66.7	65.2	64.4
3	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–
5	69.0	67.8	67.2	69.2	69.7	68.9	68.6
6	–	–	–	–	–	–	–
7	57.0	58.0	58.0	–	–	–	57.7
8	58.8	55.9	–	–	–	–	57.4
9	–	–	–	–	–	–	–
10	41.6	41.8	47.8	49.8	50.6	46.0	46.3
11	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–
13	–	–	–	–	–	–	–
14	60.5	60.1	58.7	59.8	62.5	62.6	60.7
15	64.1	64.4	63.9	63.6	63.8	63.3	63.9
16	–	–	–	–	–	–	–
17	67.3	68.6	63.4	64.1	65.0	63.6	65.3
18	51.3	52.1	52.5	–	–	–	52.0
19	58.1	56.9	56.6	57.5	57.2	58.1	57.4
20	53.2	54.8	54.8	56.8	56.0	53.2	54.8
21	–	–	–	–	–	–	–
22	63.4	66.9	63.2	63.8	67.2	69.6	65.7
23	–	–	–	–	–	–	–
24	52.9	54.7	54.8	54.2	53.6	52.9	53.9
25	58.4	65.8	62.8	62.2	63.2	60.5	62.2
26	65.8	65.4	65.4	63.0	62.0	65.7	64.6
27	62.1	60.0	59.4	59.4	60.7	58.4	60.0
28	–	–	–	–	–	–	–
29	38.0	39.0	38.0	–	–	–	38.3
30	39.7	42.2	41.0	42.3	41.2	40.9	41.2
31	36.2	35.9	36.2	–	–	–	36.1
32	–	–	–	–	–	–	–
33	–	–	–	–	–	–	–
34	56.5	55.4	55.5	57.4	55.1	56.1	56.0
35	67.9	64.6	64.5	67.1	66.5	65.3	66.0
36	65.1	64.1	63.9	65.1	64.2	63.4	64.3

APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

37	66.0	62.2	65.6	62.7	63.6	65.6	64.3
38	61.6	63.1	62.5	61.7	63.4	60.3	62.1
39	54.0	55.7	54.9	55.9	56.8	56.3	55.6
40	–	–	–	–	–	–	–
41	–	–	–	–	–	–	–
42	–	–	–	–	–	–	–
43	–	–	–	–	–	–	–
44	–	–	–	–	–	–	–
45	56.5	56.5	56.9	54.6	55.9	56.9	56.2
46	58.8	56.8	57.4	55.9	59.6	60.2	58.1
47	59.0	59.2	61.1	61.6	58.4	58.9	59.7
48	55.0	55.3	54.7	55.0	54.4	55.3	55.0
49	43.8	46.6	44.4	42.2	49.7	46.6	45.6
50	48.4	49.6	47.2	45.8	45.1	50.6	47.8
51	49.1	48.9	47.1	46.6	43.3	46.9	47.0
52	64.1	62.2	65.0	61.3	63.8	66.3	63.8
53	70.1	68.8	66.3	67.6	65.8	68.7	67.9
54	59.1	60.9	58.9	55.8	61.5	63.8	60.0
55	61.6	62.5	59.4	61.3	60.9	61.6	61.2
56	60.7	64.7	60.2	62.6	63.0	61.1	62.1
57	57.5	55.9	58.7	56.5	55.8	57.6	57.0
58	66.3	65.4	67.1	65.4	67.4	66.3	66.3
59	55.9	55.3	56.9	56.3	56.9	56.3	56.3
60	65.2	64.4	64.7	64.7	65.0	64.3	64.7
61	60.9	62.5	62.2	59.9	61.5	59.3	61.1
62	65.7	64.8	65.1	64.2	66.0	64.7	65.1
63	65.4	66.2	65.1	66.8	62.0	66.2	65.3
64	55.9	56.1	56.0	57.0	55.9	56.4	56.2
65	54.5	55.2	56.7	57.0	55.4	56.3	55.9
66	64.1	64.3	65.0	64.6	63.4	66.1	64.6
67	67.1	67.9	65.9	67.5	67.4	70.1	67.7
68	64.2	63.6	67.5	67.9	63.9	65.0	65.4
69	–	–	–	–	–	–	–
70	67.6	67.3	69.8	68.1	70.2	69.8	68.8
71	–	–	–	–	–	–	–
72	65.7	66.8	67.9	66.6	67.1	64.8	66.5
73	71.3	67.9	68.5	66.5	63.2	65.6	67.2
74	64.4	65.3	65.1	65.6	65.1	65.6	65.2
75	61.7	57.3	62.6	64.1	62.4	61.9	61.7
76	64.8	62.8	63.2	62.8	64.4	63.6	63.6

APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

77	62.8	63.1	62.4	62.4	64.4	64.3	63.2
78	62.2	63.2	62.5	63.5	64.2	62.5	63.0
79	65.0	64.7	65.2	63.8	63.5	64.4	64.4
80	64.5	63.4	64.3	63.9	63.6	62.9	63.8
81	61.7	62.8	63.0	60.9	61.9	62.1	62.1
82	59.8	63.0	63.1	63.2	64.4	61.5	62.5
83	64.0	65.2	64.9	64.0	63.8	63.2	64.2
84	63.8	63.2	62.8	63.3	62.6	62.8	63.1

Number of Results	64
Median	62.1
Minimum Data	36.1
Maximum Data	68.8
Range	32.7
Robust CV (%)	9.91
First Quartile	56.3
Third Quartile	64.6
Inter Quartile Range	8.30
Normalized IQR	6.16

Fig 2 Histogram of Compressive Strength Test Results - Sample B

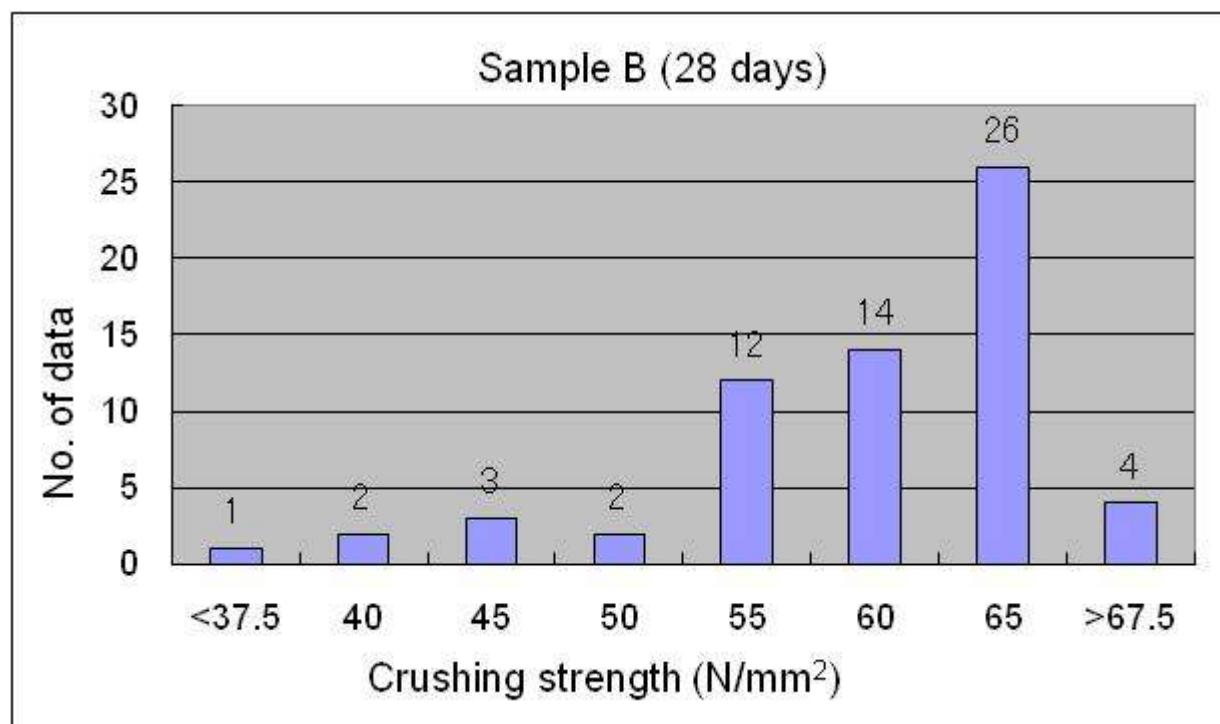


Table A.3 z-score for Individual Samples, Between Laboratories and Within Laboratory

Lab code	Test results		z-score				Between Laboratories z-score (ZB)	Within Laboratory z-score (ZW)	
	Sample A 7 days	Sample B 28 days	Sample A (Za)		Sample B (Zb)				
1	47.4	64.0	0.59		0.30		0.33	0.14	
2	48.1	64.4	0.81		0.36		0.44	0.03	
3	–	–	–		–		–	–	
4	–	–	–		–		–	–	
5	51.8	68.6	1.92		1.06		1.29	0.20	
6	–	–	–		–		–	–	
7	46.5	57.7	0.34		–0.72		–0.44	–1.51	
8	33.9	57.4	–3.44	§	–0.78		–1.82	2.21	?
9	–	–	–		–		–	–	
10	31.6	46.3	–4.11	§	–2.58	?	–3.24	§ –0.45	
11	–	–	–		–		–	–	
12	–	–	–		–		–	–	
13	–	–	–		–		–	–	
14	44.0	60.7	–0.42		–0.23		–0.39	0.17	
15	43.8	63.9	–0.46		0.28		–0.06	1.16	
16	–	–	–		–		–	–	
17	55.0	65.3	2.88	?	0.52		1.29	–1.76	
18	40.1	52.0	–1.57		–1.65		–1.73	–1.30	
19	41.1	57.4	–1.27		–0.77		–1.04	0.04	
20	46.6	54.8	0.36		–1.19		–0.74	–2.39	?
21	–	–	–		–		–	–	
22	46.2	65.7	0.24		0.58		0.38	1.01	
23	–	–	–		–		–	–	
24	43.9	53.9	–0.45		–1.34		–1.12	–1.86	
25	54.2	62.2	2.64	?	0.00		0.86	–2.48	?
26	44.1	64.6	–0.39		0.39		0.04	1.30	
27	44.8	60.0	–0.18		–0.35		–0.37	–0.28	
28	–	–	–		–		–	–	
29	28.3	38.3	–5.08	§	–3.86	§	–4.43	§ –1.86	
30	29.9	41.2	–4.61	§	–3.40	§	–3.95	§ –1.47	
31	27.2	36.1	–5.43	§	–4.23	§	–4.79	§ –2.18	?
32	–	–	–		–		–	–	
33	–	–	–		–		–	–	
34	43.1	56.0	–0.66		–0.99		–0.97	–1.00	

APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

35	47.6	66.0	0.66		0.63		0.56		0.67	
36	47.1	64.3	0.52		0.35		0.33		0.31	
37	47.1	64.3	0.53		0.35		0.33		0.30	
38	44.7	62.1	-0.19		0.00		-0.15		0.36	
39	42.6	55.6	-0.82		-1.06		-1.07		-0.96	
40	-	-	-		-		-		-	
41	-	-	-		-		-		-	
42	-	-	-		-		-		-	
43	-	-	-		-		-		-	
44	-	-	-		-		-		-	
45	39.8	56.2	-1.65		-0.96		-1.30		0.06	
46	41.3	58.1	-1.21		-0.65		-0.94		0.19	
47	45.4	59.7	0.02		-0.39		-0.33		-0.57	
48	87.9	55.0	12.71	§	-1.17		3.68	§	-14.80	§
49	34.0	45.6	-3.40	§	-2.69	?	-3.06	§	-1.38	
50	35.4	47.8	-2.99	?	-2.33	?	-2.68	?	-1.13	
51	34.7	47.0	-3.20	§	-2.46	?	-2.84	?	-1.16	
52	44.7	63.8	-0.20		0.27		0.02		0.88	
53	51.9	67.9	1.94		0.94		1.22		-0.05	
54	43.8	60.0	-0.46		-0.35		-0.47		0.00	
55	44.5	61.2	-0.25		-0.15		-0.27		0.16	
56	47.9	62.1	0.76		-0.01		0.18		-0.61	
57	43.8	57.0	-0.46		-0.83		-0.79		-0.90	
58	47.7	66.3	0.69		0.68		0.61		0.75	
59	43.0	56.3	-0.72		-0.95		-0.96		-0.86	
60	45.4	64.7	0.00		0.42		0.19		0.96	
61	43.9	61.1	-0.43		-0.17		-0.35		0.28	
62	50.2	65.1	1.46		0.48		0.75		-0.40	
63	50.0	65.3	1.39		0.51		0.75		-0.27	
64	43.1	56.2	-0.66		-0.96		-0.95		-0.93	
65	42.6	55.9	-0.82		-1.02		-1.05		-0.88	
66	49.2	64.6	1.14		0.40		0.58		-0.23	
67	49.6	67.7	1.25		0.90		0.95		0.58	
68	49.2	65.4	1.14		0.52		0.66		0.00	
69	-	-	-		-		-		-	
70	48.7	68.8	0.98		1.08		0.98		1.20	
71	-	-	-		-		-		-	
72	51.5	66.5	1.83		0.71		1.03		-0.35	
73	50.2	67.2	1.45		0.82		0.97		0.23	
74	45.4	65.2	0.02		0.50		0.25		1.08	

APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

75	46.2	61.7	0.26		-0.07		-0.04		-0.22	
76	45.9	63.6	0.17		0.24		0.13		0.45	
77	47.3	63.2	0.57		0.18		0.24		-0.06	
78	45.4	63.0	0.00		0.14		0.01		0.44	
79	46.8	64.4	0.43		0.37		0.31		0.44	
80	46.4	63.8	0.31		0.27		0.20		0.36	
81	42.6	62.1	-0.83		-0.01		-0.39		1.00	
82	47.6	62.5	0.66		0.06		0.19		-0.38	
83	45.1	64.2	-0.07		0.33		0.11		0.87	
84	45.1	63.1	-0.08		0.16		-0.01		0.55	

Fig 3 z-score Distribution – Sample A

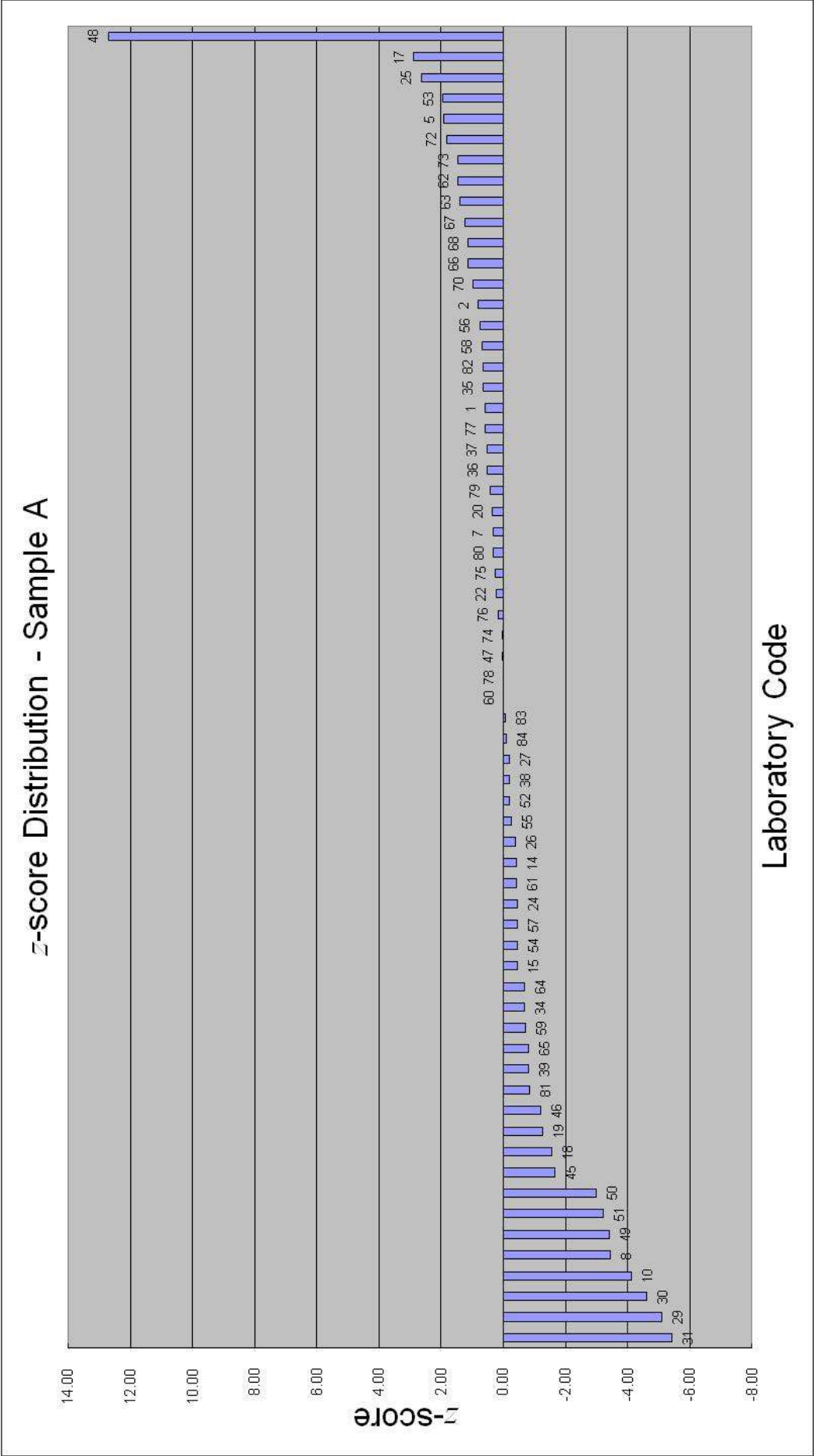


Fig 4 z-score Distribution – Sample B

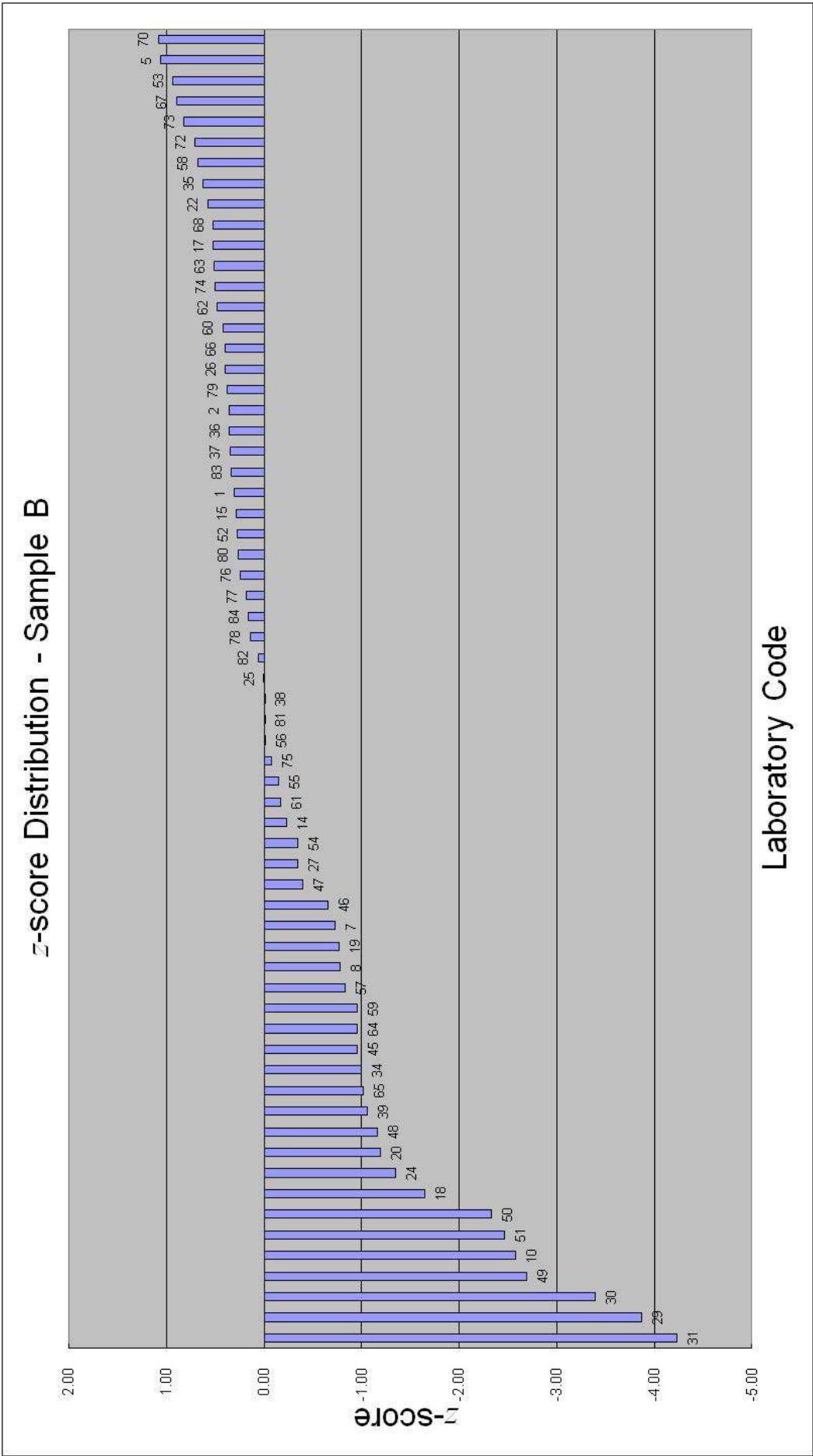


Fig 5 z-score Distribution - Between Laboratories z-score (ZB)

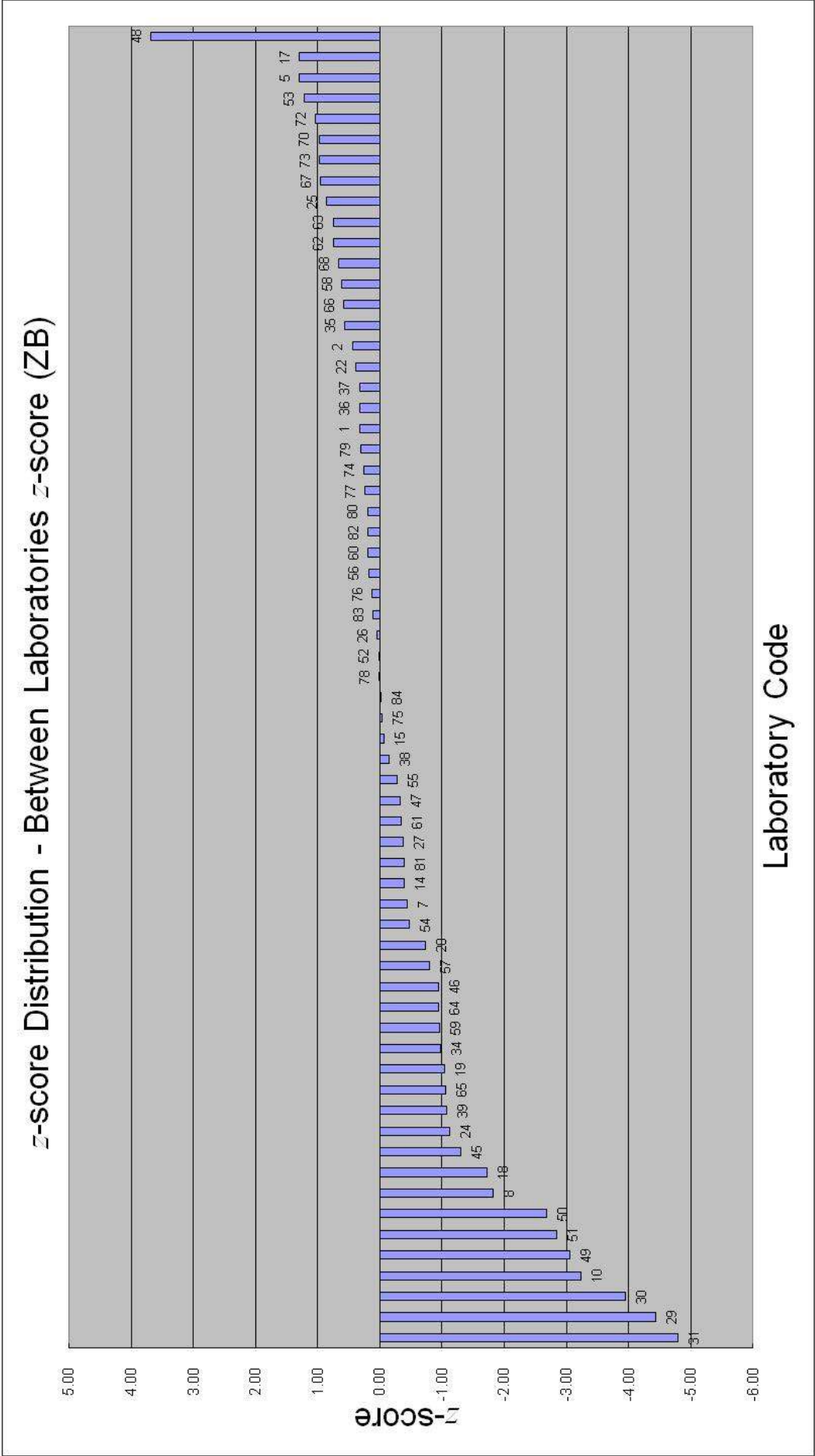


Fig 6 z-score Distribution - Within Laboratory z-score (ZW)

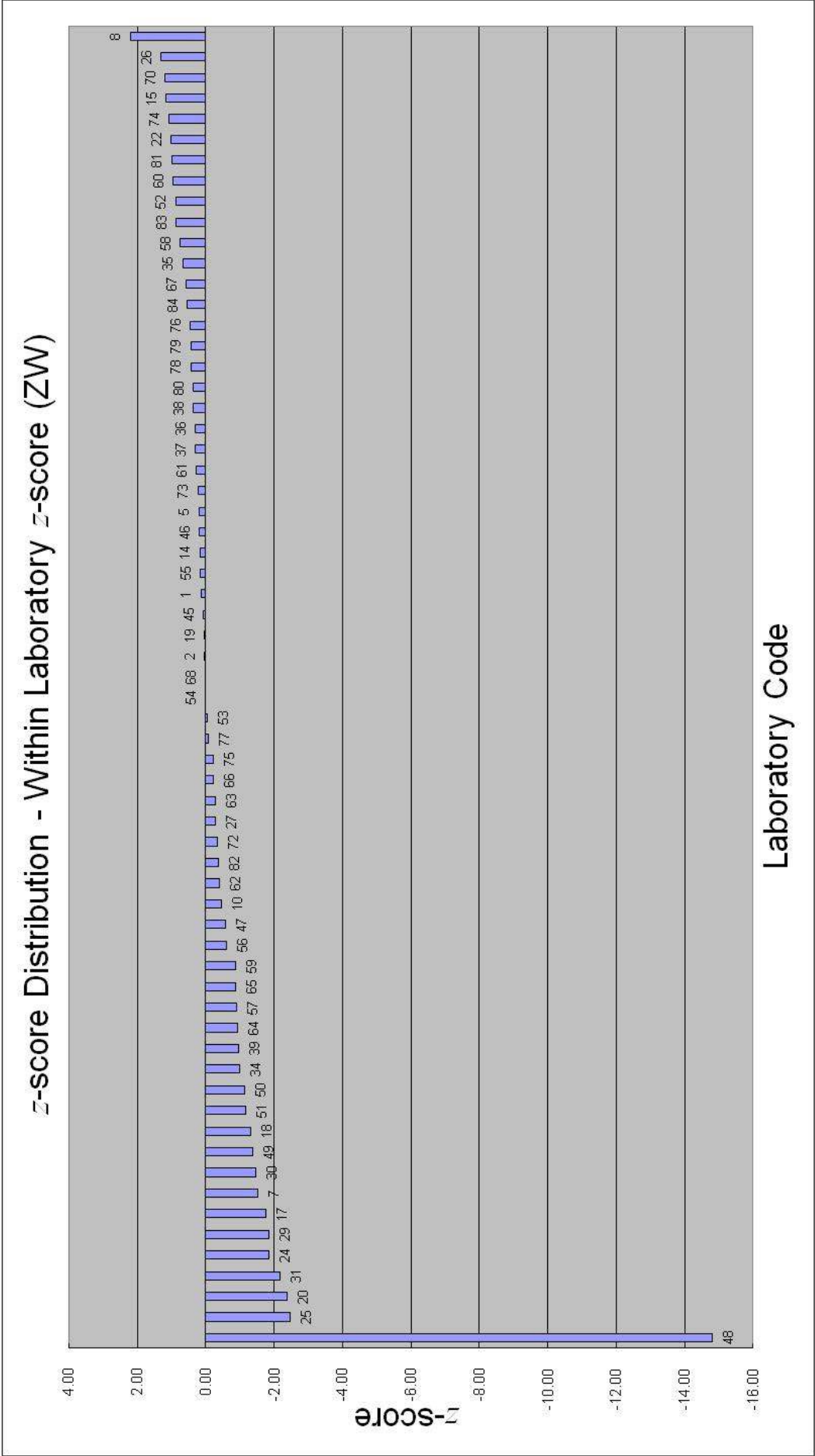
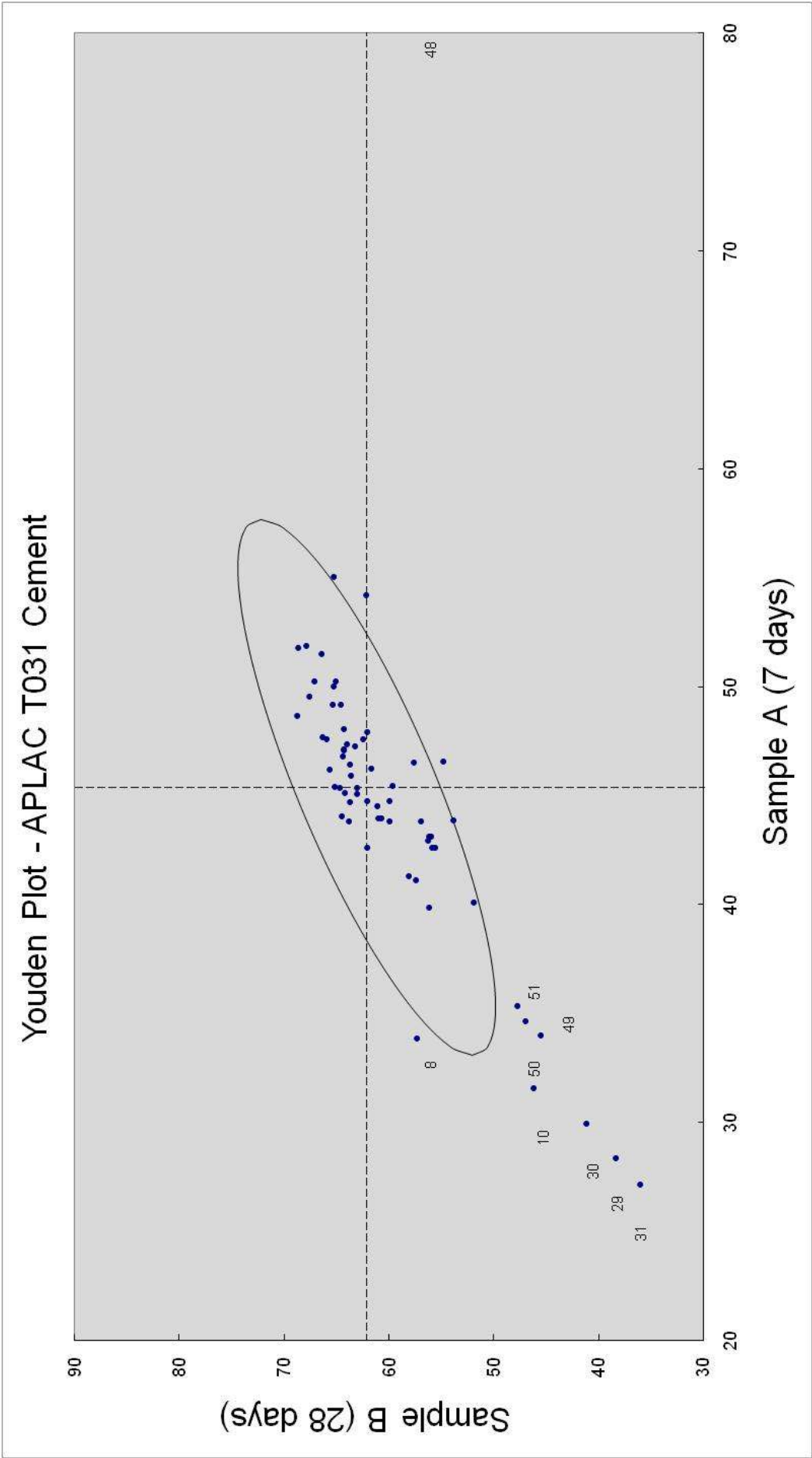


Fig 7 Youden Plot – APLAC T031 Cement



APPENDIX B TEST SPECIMEN

1) Normal Portland cement for strength tests

2) Standard testing sand

Grades of the standard testing sand used for this proficiency testing program are as follows:

Square mesh size [mm]	Cumulative Sieve Residue [%]
2	0
1.6	7 ± 5
1	33 ± 5
0.5	67 ± 5
0.16	87 ± 5
0.08	99 ± 1

Moisture content: less than 0.2 %

Specific gravity: 2.64

APPENDIX C HOMOGENEITY TEST RESULTS

1. Environmental conditions for preparation, molding curing and test of specimens

Testing environment in preparing test pieces, curing, and temperature/humidity in tests before the tests are as follows:

Table C.1 Results of Homogeneity Test

		A	B	C	D	E	F
Molding room	Temperature (°C)	21.1	21.1	21.1	21.1	21.1	21.1
	Humidity (%)	79.4	79.4	79.4	79.4	79.4	79.4
Temperature of Materials	Cement	20.8	20.8	20.8	20.8	20.8	20.8
	Mixing water	19.5	19.5	19.5	19.5	19.5	19.5
	Standard sand	20.5	20.5	20.5	20.5	20.5	20.5
Moist closet	Temperature (°C)	21.0	21.0	21.0	21.0	21.0	21.0
	Humidity (%)	99.0	99.9	99.9	99.9	99.9	99.9
Temperature of curing water	At 7 days test	20.6	20.6	20.6	20.6	20.6	20.6
	At 28 days test	19.7	19.7	19.7	19.7	19.7	19.7
Temperature of testing room	At 7 days test	22.0	22.0	22.0	22.0	22.0	22.0
	At 28 days test	25.1	25.1	25.1	25.1	25.1	25.1
Humidity of testing room	At 7 days test	22.8	22.8	22.8	23.3	23.3	23.3
	At 28 days test	29.1	29.1	29.1	29.6	29.6	29.6

*: Jolting equipment specified in ISO 679 was used for preparation of test pieces.

2. Test method

The strength test of the test pieces were performed with the methods specified in the ISO 679.

2.1 Measurement of the mass

The mass of the test pieces was measured with electronic balances with maximum capacity of 3 100 g (minimum reading: 0.1g)

2.2 Compression test machine

Compressive strength test machine with maximum capacity of 200 kN was used.

The major specifications of the test machine are:

Name of type (Manufacturer): TONI COMP III (TONI Germany)

Maximum capacity: 200 kN (automatic range)

Accuracy: JIS B7733:1997, Grade 1 (JIS B7721:1997, ISO7500-1:1986)

2.3 Handling of the test specimen

Test pieces were taken out of the curing tank immediately before the test and wrapped with wet towel until measurement.

2.4 Conditions of compressive strength test

The loading speeds applied during the compressive strength tests were as follows:

Table C.2 Loading speed (Unit: N/s)

Specimen ID		A	B	C	D	E	F
7 days	Average	2 272.84	2 260.49	2 284.54	2 277.25	2 270.30	2 271.09
	Minimum	2 251.46	2 254.55	2 272.15	2 251.55	2 266.23	2 254.66
	Maximum	2 301.24	2 279.76	2 296.30	2 289.16	2 276.40	2 287.97
28 days	Average	2 317.93	2 322.15	2 317.90	2 348.09	2 320.05	2 318.47
	Minimum	2 304.55	2 315.56	2 305.94	2 311.11	2 308.04	2 310.81
	Maximum	2 325.89	2 331.84	2 327.19	2 502.27	2 339.37	2 331.82

3. Homogeneity test results

Specimen ID	Water-Cement ratio	Compressive strength test				Mass of test specimen (g)			
		Max. Load w(N)		Compressive strength c(N/mm ²)		Immediately after demoulding		Immediately before the test	
		7 days	28 days	7 days	28 days	7 days	28 days	7 days	28 days
A	50	77.0	104.5	48.1	65.3	590	593	593	597
		72.8	103.4	45.5	64.6				
		74.1	105.9	46.3	66.2	592	590	594	594
		71.7	101.4	44.8	63.4				
		76.2	104.2	47.6	65.1	592	592	595	595
		74.1	104.6	46.3	65.4				
	Average	–	–	46.4	65.0	591	592	594	595
	STD	–	–	1.24	0.94	–	–	–	–

APLAC T031 CEMENT PROFICIENCY TESTING PROGRAM

B	50	74.4	104.2	46.5	65.1	590	592	592	596
		75.2	106.2	47.0	66.4				
		76.6	103.5	47.9	64.7	591	591	593	595
		74.4	101.1	46.5	63.2				
		73.3	102.4	45.8	64.0	593	592	596	596
		72.8	104.0	45.5	65.0				
	Average	–	–	46.5	64.7	591	592	594	596
	STD	–	–	0.86	1.08	–	–	–	–
C	50	73.0	101.0	45.6	63.1	592	594	594	598
		71.8	101.8	44.9	63.6				
		73.0	101.0	45.6	63.1	593	592	596	595
		74.4	103.2	46.5	64.5				
		73.8	105.9	46.1	66.2	593	594	596	597
		73.1	106.9	45.7	66.8				
	Average	–	–	45.7	64.5	593	593	595	597
	STD	–	–	0.54	1.61	–	–	–	–
D	50	75.5	104.0	47.2	65.0	593	596	596	600
		72.5	105.4	45.3	65.9				
		75.7	99.5	47.3	62.2	597	592	599	596
		76.0	102.1	47.5	63.8				
		72.2	106.6	45.1	66.6	594	595	597	599
		72.5	104.5	45.3	65.3				
	Average	–	–	46.3	64.8	595	594	597	598
	STD	–	–	1.16	1.58	–	–	–	–
E	50	73.0	101.3	45.6	63.3	594	592	596	596
		69.8	101.8	43.6	63.6				
		73.9	103.4	46.2	64.6	591	594	594	598
		73.1	102.1	45.7	63.8				
		72.8	104.2	45.5	65.1	595	591	597	595
		73.3	103.4	45.8	64.6				
	Average	–	–	45.4	64.2	593	592	596	596
	STD	–	–	0.91	0.70	–	–	–	–
F	50	74.6	102.2	46.6	63.9	593	594	596	598
		72.3	100.6	45.2	62.9				
		72.6	102.6	45.4	64.1	592	593	594	597
		71.5	102.6	44.7	64.1				
		73.3	103.4	45.8	64.6	593	590	596	594
		72.2	101.6	45.1	63.5				
	Average	–	–	45.5	63.8	593	592	595	596
	STD	–	–	0.66	0.58	–	–	–	–
Total Average		–	–	46.0	64.5	593	593	595	596
Total STD		–	–	1.0	1.1	–	–	–	–

APPENDIX D INSTRUCTIONS TO PARTICIPANTS

APLAC T031-PROFICIENCY TESTING PROGRAM (Compressive strength test for Cement) INSTRUCTIONS TO THE PARTICIPANTS

To ensure that the results obtained from this program can be analysed properly, the participants are asked to adhere carefully to the following instructions:

1. The test sample

- Ordinary portland cements (one bag with 2 kg) packed in the aluminum foil bag.
- Standard sand (two bags with 2.7 kg/each 1 350 g) packed in the polyethylene bag.

2. The operation from the test sample arrival to the test setting

Please confirm the presence of trouble, and report the result with the attached paper receipt vote when you receive the test sample. If the trouble is found, the same one is sent again.

Please keep it in an appropriate indoor place until the testing begins.

3. The test method

- (1) Compressive strength test is executed based on ISO 679 (Methods of testing cements - Determination of strength). It reports on the outline when there is deviating from ISO 679.
- (2) The samples of 7 day material age and 28 day material age are tested.

4. Report of the test result

Testing should commence as soon as possible after receiving the samples and the results should be reported NOT LATER THAN 31 APRIL 2002. Send the completed RESULTS SHEET and any supporting documentation to your Accreditation Body and fax a copy of the RESULTS SHEET to the person in charge who shows in clause 5.

5. Contact Person and Coordinating Body

Ryozo Sobue
Senior Chief
Testing Laboratories Accreditation Division
Conformity Assessment Center
National Institute of Technology and Evaluation
2-49-10, Nishihara, shibuya-ku, Tokyo 151-0066, Japan
Phone. 03-3481-1939 Fax. 03-3481-1937
E-mail: sobue-ryozo@meti.go.jp

RECEIPT FORM
APLAC T031
(Compressive strength test for Cement)

In order to monitor the progress of this proficiency testing program, we kindly ask each participants, on receipt of the samples, to fill out this RECEIPT FORM and fax it to:

Ryozo Sobue
Testing Laboratories Accreditation Division
Conformity Assessment Center
National Institute of Technology and Evaluation
2-49-10, Nishihara, shibuya-ku, Tokyo 151-0066, Japan
Fax. 03-3481-1937
E-mai: sobue-ryozo@meti.go.jp

Thank you in advance for your cooperation.

The APLAC T027 samples were received on: _____ (date)

Comments:

Participating Accreditation Body: _____

Contact Person: _____ Fax: _____

APLAC T031 Cement Proficiency Testing Report

Report date: _____

Office Name: _____

Testing Person in
charge signature: _____Those who execute
testing signature: _____

Address _____

TEL: _____

FAX: _____

E-mail: _____

1. Use material weight

Use Material	Measured weight (g)	
	7 day material age	28 day material age
Cement		
Standard sand		
Water		

Mixing & molding date: _____

Testing date of 7-day material: _____

Testing date of 28-day material: _____

Note 1 It weights it in every the minimum scale 0.1 g.

Note 2 The standard sand measures the mass by using the whole quantity of the polyethylene bag.

2. Various conditions of environment, curing & form (at the forming)

Forming & testing room		Material temperature (°C)			Moist closet		Curing water temperature (°C)	
Temperature (°C)	Humidity (%)	Standard cement	Water for kneading	Standard sand	Temperature (°C)	Humidity (%)	7 day	28 day
Form stuffing machine								
Table Vibrator		Jolting Machine						

Note 1 The temperature measures the digit up to 0.1 °C

Note 2 Measurements of humidity are rounded to the integer

Note 3 Forms stuffing machine fills in O sign on the one used.

3. Strength Test Results

Water-cement ratio (%)	Compressive strength test				Specimen mass			
	Maximum load w(N)		Crushing strength c(N/mm ²)		Just behind demold		just before testing, just behind colander	
	7 day	28 day	7 day	28 day	7 day	28 day	7 day	28 day
50								
Mean	—	—						
Standard deviation	—	—						

Note 1 Compressive strength is rounded to one digit below the decimal point.

Note 2 The specimen mass is rounded to the integer.

Note 3 The standard deviation is rounded to two digits below the decimal point.

4. Compressive strength test loading rate (control method Auto Manual)

O sign is put on the corresponding one

Note 1 Fill in the loading rate record of each time testing if the loading rate control of the tester used is a manual operation.

Note 2 It requests it by setting the load of two points (low stress and high rates of loading) through that the measurement of the loading rate is suitable executing immediately after the loading and the vicinity of the ultimate load, and measuring the time required between those.

Note 3 It is good in one measurement in the case with a tester of the loading rate automatic control in each material age.

Material age	Load range (kN)	Time (s)	Loading rate (N/s)	Note
7 day	~			AVG: N/s MIN: N/s MAX: N/s
	~			
	~			
	~			
	~			
	~			
28 day	~			AVG: N/s MIN: N/s MAX: N/s
	~			
	~			
	~			
	~			
	~			

Note 1 A minimum scale is measured in 0.1 seconds at time.

Note 2 The loading rate is rounded to two digits below the decimal point.

5. Matter which should be specially described (Please make and describe the attached paper when it is not possible to write in this column.)

Please describe the handling of the test specimen when the compressive strength test is executed, curing and the environment in detail

The presence and the content of trouble of mortar test specimen

Weighing used for mass measurement of material and test specimen (description like scale interval, weighing, manufacturer name, and model, etc.)

Compression tester used for testing (Details like the weighing capacity, accuracy, the used range, the manufacturer name, and the model, etc. are described.)

Content when presence of deviating matter and deviating from ISO 679:1989