CETANZ

Civil Engineering Testing Association of New Zealand

TECHNICAL REPORT ON

LINEAR SHRINKAGE PROFICIENCY 2011

CETANZ Technical Report	**TR 2**
Author(s)	**Dr Jackie Graham, PQ Systems Pty Ltd**
Report Date – First Issue	**January 2012**
Report Revision Date	**-**
Revision Number	**-**
Associated Test Method(s)	**NZS 4402: 1986: Test 2.6.1**

LINEAR SHRINKAGE PROFICIENCY 2011

1. Introduction

This report serves to summarise the results of the 2010 CETANZ Linear Shrinkage Testing Proficiency.

In September 2010 CETANZ arranged a Plasticity Index and Linear Shrinkage test proficiency. OPUS Hamilton volunteered to design, prepare and distribute samples to approximately 27 New Zealand Laboratories. PQ Systems Pty Ltd was engaged to carry our data analysis. Three different soil samples were sent in duplicate to the following laboratories:

Babbage Geotechnical Laboratory
Central Testing Services – Alexandra
Civil Engineering Laboratory Services Ltd – Nelson
Coffey Information - East Tamaki
Coffey Information - Tauranga
Downer– Auckland
Downer– Christchurch
Envirolab Geotest
Fulton Hogan Laboratory – Dunedin
Geotechnics - Auckland
Geotechnics - Tauranga
Higgins
Holcim Laboratory – Auckland
Materials Advisory and Testing Services
Northland Soil Mechanics & Testing – Whangarei
OPUS International Consultants - Auckland
OPUS International Consultants - Dunedin
OPUS International Consultants - Gisborne
OPUS International Consultants - Hamilton
OPUS International Consultants - Napier
OPUS International Consultants - New Plymouth
OPUS International Consultants - Rotorua
OPUS International Consultants - Tauranga
OPUS International Consultants - Wanganui
OPUS International Consultants - Whangarei
Stevenson Laboratory Ltd
Test Lab – Wanganui

Laboratories were issued laboratory identification numbers by Keith Towl of IANZ so as to keep the identity of the laboratory confidential. All results were returned before the end of November 2011. Laboratories # 22 & 25 did not return results.

The purpose of the scheme was to:

1. Provide results that should enable participants to improve their performance.
2. Provide information relevant for calculation of uncertainty.
3. Contribute to confidence of mutual users of Civil Engineering Laboratories.
4. Identify problems with, or between, Laboratories.
5. Provide an indication of the industry's ability to perform the test method.
6. Potentially identifying needs for test method improvement.

2. Sample Preparation

Three materials (Silty Clays) were selected from the Auckland – Waikato region representing three significantly different linear shrinkage values. The bulk samples were rotary hoed and mixed to ensure homogeneity. Test Samples were split into representative test portions and sent to laboratories. Laboratories were asked to carry out the test as detailed in the method and ensure that the same technician completed all tests. Laboratories were asked to completed a result return form and attaché laboratory I.D. as assigned by IANZ and return results to OPUS Laboratory Hamilton.

3. Analysis

Analysis has been carried out by Dr Jackie Graham of PQ Systems Pty Ltd. The final report for which is included in this document.

4. Conclusion

See executive summary to follow.

5. References

NZS 4402: 1986: Test 2.6.1. Determination of The Linear Shrinkage

4. Disclaimer

CETANZ

Linear shrinkage test results

2011

Report prepared by Dr Jackie Graham,
PQ Systems Pty Ltd
Suite 5, 395 Nepean Highway
Frankston VIC 3199
Phone: +61 3 9770 1960
jackie@pqsystems.com.au

Executive summary

This assessment reviews linear shrinkage. 3 samples were prepared and each laboratory received 2 portions of each sample. The ability of the laboratory to produce the same results from the same sample is assessed along with a comparison between the laboratories. The finding of the study is as follows:

- Z-scores have been used to analyse the individual results and show questionable results for laboratories 1, 3, 11, 16, and 27.
- Strong biases are present. Laboratories 1, 9, 15, 17, and 27 show a high bias. Whilst laboratories 2, 7, 11, 16, and 26 have a low bias.
- Laboratory 3 was found to have repeatability issues; indicating a poor ability to get similar results when testing portions of the same sample.

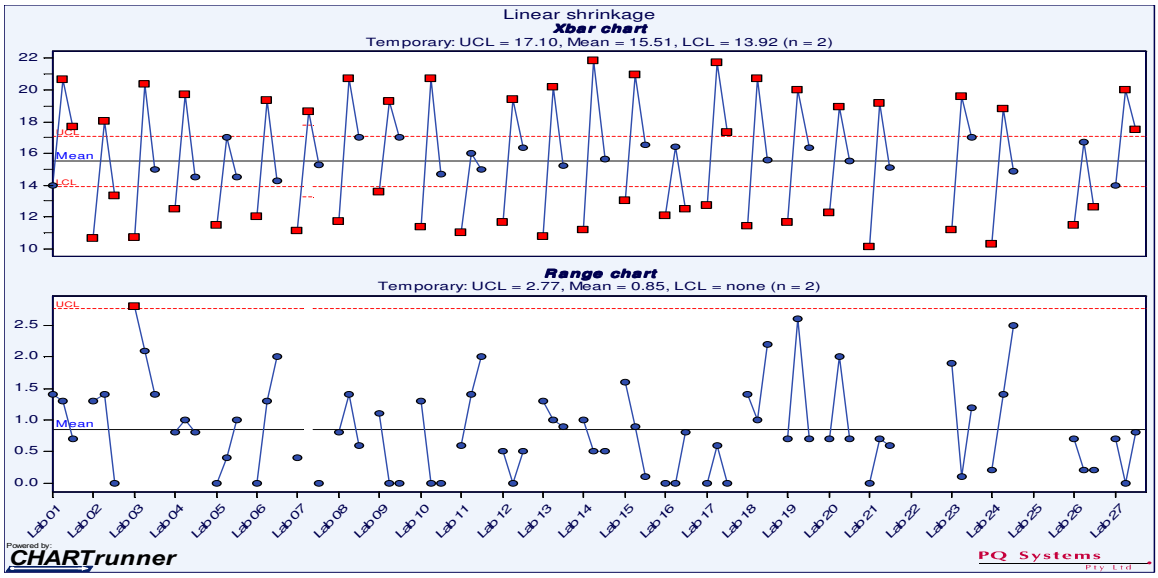
Linear shrinkage in comparison to study averages

In this analysis the difference between the individual laboratory results and the overall study average is shown. Also on the table is the z-score. Z-scores are interpreted as follows: a score less than or equal to 2 is considered satisfactory, a score greater than 2 but less than or equal to 3 is considered questionable while a score greater than 3 is considered unsatisfactory.

Lab ID	Test #	Sample A			Sample B			Sample C		
		Linear Shrinkage	Difference from average	z-score	Linear Shrinkage	Difference from average	z-score	Linear Shrinkage	Difference from average	z-score
Lab 1	1	13.3	2	1.31	20.0	1	0.36	18.0	2.5	1.68
Lab 1	2	14.7	3	2.50	21.3	2	1.13	17.3	1.8	1.22
Lab 2	1	11.3	0	0.38	18.7	-1	0.42	13.3	-2.2	1.43
Lab 2	2	10.0	-2	1.48	17.3	-2	1.26	13.3	-2.2	1.43
Lab 3	1	12.1	0	0.30	21.4	2	1.19	15.7	0.2	0.16
Lab 3	2	9.3	-2	2.07	19.3	0	0.06	14.3	-1.2	0.77
Lab 4	1	12.9	1	0.98	20.2	1	0.48	14.9	-0.6	0.37
Lab 4	2	12.1	0	0.30	19.2	0	0.12	14.1	-1.4	0.90
Lab 5	1	11.5	0	0.21	17.2	-2	1.32	14.0	-1.5	0.96
Lab 5	2	11.5	0	0.21	16.8	-3	1.56	15.0	-0.5	0.30
Lab 6	1	12.0	0	0.21	20.0	1	0.36	13.3	-2.2	1.43
Lab 6	2	12.0	0	0.21	18.7	-1	0.42	15.3	-0.2	0.10
Lab 7	1	10.9	-1	0.72				15.3	-0.2	0.10
Lab 7	2	11.3	0	0.38	18.6	-1	0.48	15.3	-0.2	0.10
Lab 8	1	12.1	0	0.30	20.0	1	0.36	17.3	1.8	1.22
Lab 8	2	11.3	0	0.38	21.4	2	1.19	16.7	1.2	0.82
Lab 9	1	14.1	2	1.99	19.3	0	0.06	17.0	1.5	1.02
Lab 9	2	13.0	1	1.06	19.3	0	0.06	17.0	1.5	1.02
Lab 10	1	10.7	-1	0.89	20.7	1	0.78	14.7	-0.8	0.50
Lab 10	2	12.0	0	0.21	20.7	1	0.78	14.7	-0.8	0.50
Lab 11	1	10.7	-1	0.89	15.3	-4	2.45	16.0	0.5	0.36
Lab 11	2	11.3	0	0.38	16.7	-3	1.62	14.0	-1.5	0.96
Lab 12	1	11.9	0	0.13	19.4	0	0.00	16.1	0.6	0.43
Lab 12	2	11.4	0	0.29	19.4	0	0.00	16.6	1.1	0.76
Lab 13	1	10.1	-2	1.40	19.7	0	0.18	14.8	-0.7	0.43
Lab 13	2	11.4	0	0.29	20.7	1	0.78	15.7	0.2	0.16
Lab 14	1	11.7	0	0.04	21.6	2	1.31	15.4	-0.1	0.04
Lab 14	2	10.7	-1	0.89	22.1	3	1.61	15.9	0.4	0.29
Lab 15	1	13.8	2	1.74	20.5	1	0.66	16.6	1.1	0.76
Lab 15	2	12.2	0	0.38	21.4	2	1.19	16.5	1.0	0.69
Lab 16	1	12.1	0	0.30	16.4	-3	1.79	12.1	-3.4	2.22
Lab 16	2	12.1	0	0.30	16.4	-3	1.79	12.9	-2.6	1.69
Lab 17	1	12.7	1	0.81	21.4	2	1.19	17.3	1.8	1.22
Lab 17	2	12.7	1	0.81	22.0	3	1.55	17.3	1.8	1.22
Lab 18	1	10.7	-1	0.89	21.2	2	1.07	16.7	1.2	0.82
Lab 18	2	12.1	0	0.30	20.2	1	0.48	14.5	-1.0	0.63
Lab 19	1	11.3	0	0.38	21.3	2	1.13	16.7	1.2	0.82
Lab 19	2	12.0	0	0.21	18.7	-1	0.42	16.0	0.5	0.36
Lab 20	1	12.6	1	0.72	17.9	-2	0.90	15.2	-0.3	0.17
Lab 20	2	11.9	0	0.13	19.9	0	0.30	15.9	0.4	0.29
Lab 21	1	10.1	-2	1.40	18.8	-1	0.36	14.8	-0.7	0.43
Lab 21	2	10.1	-2	1.40	19.5	0	0.06	15.4	-0.1	0.04
Lab 23	1	12.1	0	0.30	19.6	0	0.12	16.4	0.9	0.62
Lab 23	2	10.2	-2	1.31	19.5	0	0.06	17.6	2.1	1.42
Lab 24	1	10.2	-2	1.31	18.1	-1	0.78	13.6	-1.9	1.23
Lab 24	2	10.4	-1	1.14	19.5	0	0.06	16.1	0.6	0.43
Lab 26	1	11.1	-1	0.55	16.8	-3	1.56	12.7	-2.8	1.82
Lab 26	2	11.8	0	0.04	16.6	-3	1.68	12.5	-3.0	1.96
Lab 27	1	14.3	3	2.16	20.0	1	0.36	17.1	1.6	1.09
Lab 27	2	13.6	2	1.57	20.0	1	0.36	17.9	2.4	1.62

Linear shrinkage comparison of results using and average and range chart

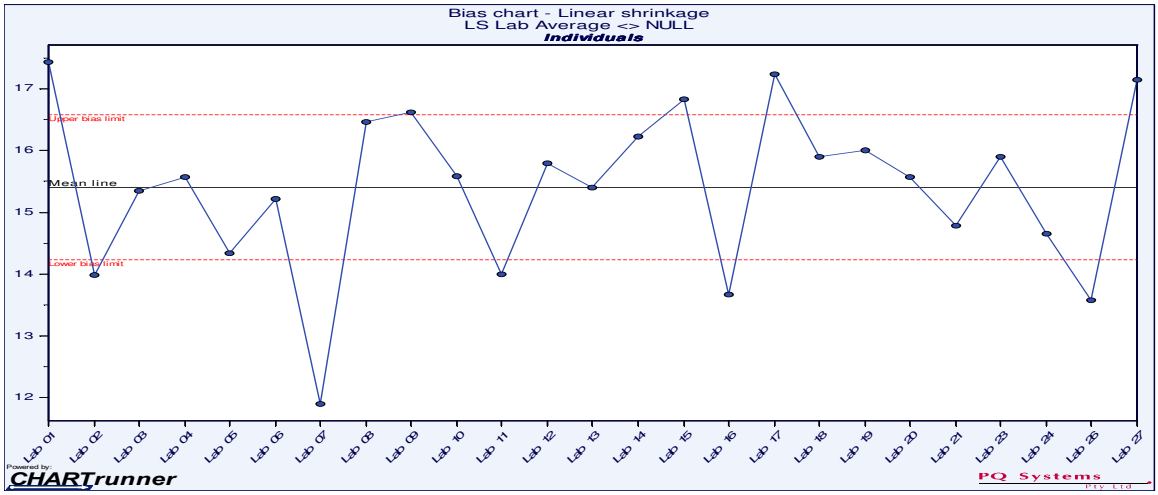
The following chart shows the results for the study.



The average chart shows the laboratories in order from 1 to 27. Each laboratory shows three results, which represents the average for sample A, B, and C. Ideally each laboratory's results should look the same. This chart indicates some bias issues maybe present; this is assessed further in the next section.

The range chart shows the differences in the test results for sample A, B, and C separately for each laboratory. It shows the average difference between test results is 0.85 units. Ideally all results will be below the upper control limit. Note that Lab 3 has a result above the upper control limit indicating the result is significantly different to all others. This is a concern as it shows an inability to repeat the test consistently; it should be noted that this could be caused by poor sample preparation. Although it is the only laboratory with a significant difference which tends to suggest a testing issue is present.

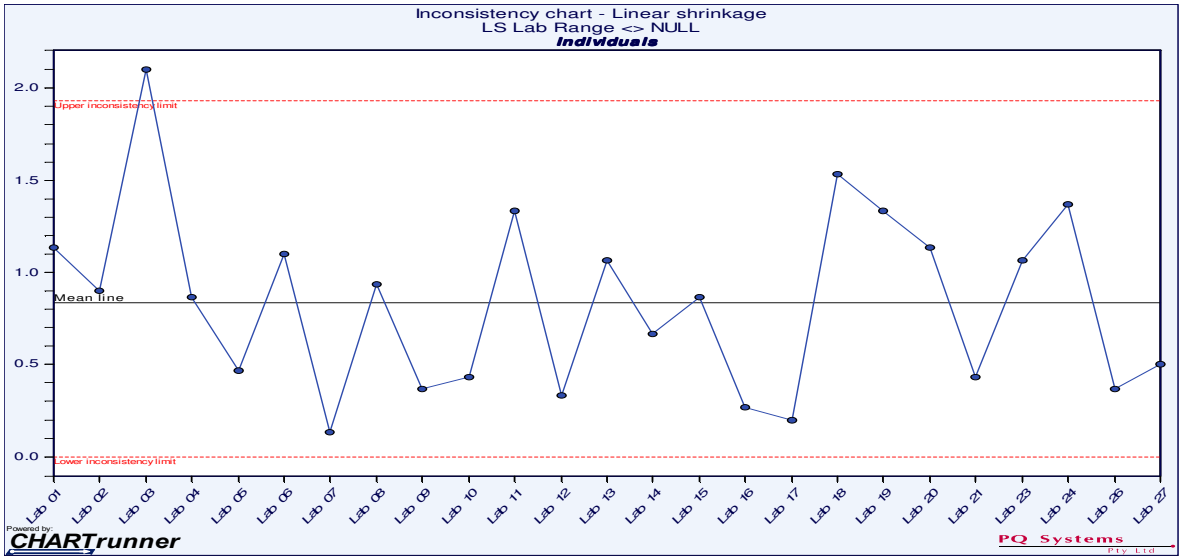
Linear shrinkage bias assessment



The bias charts takes the average for all 3 samples, 6 results, and compares them. Ideally all laboratories would be inside the control limits.

The bias chart shows that laboratories 1, 9, 15, 17, and 27 each has a high bias while laboratories 2, 7, 11, 16, and 26 each has a low bias compared to all results. These biases are statistically significant and require further assessment.

Linear shrinkage inconsistency assessment



This assessment reviews the overall ability of each laboratory to reproduce the same results by comparing the average range of the 3 sets of samples for each laboratory. Ideally all results should be inside the control limits. The inconsistency chart shows that laboratory 3 is significantly less consistent than all other laboratories.