

DUBAI ACCREDITATION DEPARTMENT

REPORT ON 190TH INTER-LABORATORY PROFICIENCY TESTING PROGRAMM DETERMINATION OF LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX

2 June 2010

1. INTRODUCTION

This document presents the results of the 190th inter-laboratory proficiency-testing program conducted during the month of April involving the determination of **Liquid Limit Plastic Limit and Plasticity Index** with thirty two laboratories participating.

This program is part of the Inter-laboratory Comparison Programs organized by Dubai Accreditation Department (DAC) of Dubai Municipality (DM) for monitoring the validity of test results of laboratories operating in Dubai as a requirement of the Local Order 52/1990 and ISO/IEC 17011: 2004.

2. EXPERIMENTAL DESIGN

2.1 Homogeneity:

DAC had ensured the homogeneity of the samples prior to their distribution to the participating laboratories by conducting homogeneity test on six samples (randomly selected). Based on the test results the homogeneity is statistically evaluated as per *ISO 13528:2005 as explained in DAC-G3-03*.

2.2 Participants:

Thirty two laboratories were participated in this program; one is governmental laboratory and twenty are private laboratories operating in the emirate of Dubai which are registered and/or accredited by DAC for construction materials testing, in addition, six participants from other emirates, and also four participants from Qatar and one from Oman.

2.3 Samples Tested:

One Sample of Clayey Soil Approximately 1 Kg was distributed to all participating laboratories.

3. CONFIDENTIALITY

Each laboratory is given a code number to maintain confidentiality of results and to protect their identities. Only the concerned laboratory knows its code number.

4. TEST METHOD

Instructions were given to the participants to test the samples as follow:

- 4.1 Determination of Liquid Limit in accordance with BS 1377:1990 Part 2 Cl. 4.5/4.3 Amd 9027:1996, Sample Preparation shall be as per Cl .4.2.4.

DUBAI ACCREDITATION DEPARTMENT

4.2 Determination of Plastic Limit and Plasticity Index as per BS 1377: 1990 Part 2 Cl.5, 5.3, 5.4 Amd .9027:1996

4.3 Use the oven at temperatures 80 C^o

5. TEST RESULTS

The test results submitted by the participating laboratories are presented in Appendix A. In order to protect the identity of the participating laboratories, each one was assigned a code number. The numbers in the column headings, Lab #, of the tables represents the code numbers for the participating laboratories.

6. EVALUATION OF RESULTS

6.1 Method of Analysis

The analysis of the participant's results is based on *ISO 13528:2005 (Statistical Methods for the Use in Proficiency Testing by Inter-laboratory Comparisons)*

6.2 Calculations of Z- scores

Appendix B gives the details of the calculation of the laboratories results and their Z-Scores which are obtained from the raw data. Also Z- Score and participant's results are represented in a bar chart and X-Y scattered plots C. The Z-Score analysis is based on an international Standard (*ISO 13528:2005*).

6.3 Outlier Results

| Test | Labs outside the z-scores ± 3 |
|------------------|---|
| Liquid Limit | Lab EX8 |
| Plastic Limit | Lab 68 |
| Plasticity Index | Lab EX8; Lab EX12; Lab 64; Lab 68; Lab 72 |

After evaluating the Z-Score the test results provided by the above mentioned laboratory is outside the Z - score limits of ± 3 , the above mentioned laboratories are requested to investigate the root cause of the outlier results and implement corrective action. For accredited laboratories evidence shall be available for checking by assessment team during the nearest assessment visit.

Also other participating laboratories have showed Z-score values higher than **two** which representing **not outlier** but a warning limit, these laboratories are advised to investigate the potential root cause of such results.

7. APPENDICES

7.1 Appendix A: Raw Data

7.2 Appendix B: Calculation of z-scores and other statistics

7.3 Appendix C: Charts

---- End of Report ----

Determination of Liquid Limit, Plastic Limit, And Plasticity Index

Appendix A: Raw Data

Table - 1 Liquid Limit %

| Lab # | Results |
|----------|---------|
| Lab G01 | 52 |
| Lab EX11 | 54 |
| Lab EX12 | 51 |
| Lab 39 | 52 |
| Lab 4 | 54 |
| Lab EX9 | 53 |
| Lab 56 | 53 |
| Lab 21 | 54 |
| Lab 7 | 51 |
| Lab EX5 | 52 |
| Lab 9 | 52 |
| Lab EX8 | 49 |
| Lab 28 | 52 |
| Lab 23 | 53 |
| Lab EX6 | 52 |
| Lab 2 | 51 |
| Lab 58 | 53 |
| Lab 64 | 51 |
| Lab 68 | 52 |
| Lab EX13 | 55 |
| Lab 72 | 52 |
| Lab 67 | 52 |
| Lab 71 | 53 |
| Lab 74 | 53 |
| Lab 35 | 53 |
| Lab 79 | 53 |
| Lab 82 | 51 |
| Lab 89 | 52 |
| Lab EX3 | 52 |
| Lab EX4 | 52 |
| Lab EX10 | 53 |
| Lab EX14 | 52 |

Table - 2 Plastic Limit %

| Lab # | Results |
|----------|---------|
| Lab G01 | 24 |
| Lab EX11 | 23 |
| Lab EX12 | 26 |
| Lab 39 | 23 |
| Lab 4 | 24 |
| Lab EX9 | 24 |
| Lab 56 | 23 |
| Lab 21 | 23 |
| Lab 7 | 24 |
| Lab EX5 | 25 |
| Lab 9 | 23 |
| Lab EX8 | 25 |
| Lab 28 | 26 |
| Lab 23 | 24 |
| Lab EX6 | 23 |
| Lab 2 | 24 |
| Lab 58 | 24 |
| Lab 64 | 26 |
| Lab 68 | 29 |
| Lab EX13 | 26 |
| Lab 72 | 27 |
| Lab 67 | 23 |
| Lab 71 | 24 |
| Lab 74 | 23 |
| Lab 35 | 24 |
| Lab 79 | 24 |
| Lab 82 | 24 |
| Lab 89 | 25 |
| Lab EX3 | 25 |
| Lab EX4 | 26 |
| Lab EX10 | 25 |
| Lab EX14 | 23 |

Table - 3 Plasticity Index

| Lab # | Results |
|----------|---------|
| Lab G01 | 28 |
| Lab EX11 | 31 |
| Lab EX12 | 25 |
| Lab 39 | 29 |
| Lab 4 | 30 |
| Lab EX9 | 29 |
| Lab 56 | 30 |
| Lab 21 | 31 |
| Lab 7 | 27 |
| Lab EX5 | 27 |
| Lab 9 | 29 |
| Lab EX8 | 24 |
| Lab 28 | 26 |
| Lab 23 | 29 |
| Lab EX6 | 29 |
| Lab 2 | 27 |
| Lab 58 | 29 |
| Lab 64 | 25 |
| Lab 68 | 23 |
| Lab EX13 | 29 |
| Lab 72 | 25 |
| Lab 67 | 29 |
| Lab 71 | 29 |
| Lab 74 | 30 |
| Lab 35 | 29 |
| Lab 79 | 29 |
| Lab 82 | 27 |
| Lab 89 | 27 |
| Lab EX3 | 27 |
| Lab EX4 | 26 |
| Lab EX10 | 28 |
| Lab EX14 | 29 |

Determination of Liquid Limit, Plastic Limit, And Plasticity Index

Appendix B: Calculation of z-scores and other statistics

Table- 1 Liquid Limit %

| Iteration | 0 | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | Z Score |
|--------------------|-------|-------|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|---------|
| $\delta = 1.5 s^*$ | --- | xi-x* | 2.22 | (xi-x*) ² | 1.75 | (xi-x*) ² | 1.64 | (xi-x*) ² | 1.61 | (xi-x*) ² | 1.60 | (xi-x*) ² | 1.59 | (xi-x*) ² | |
| $x^* - \delta$ | --- | | 49.78 | | 50.56 | | 50.69 | | 50.72 | | 50.73 | | 50.74 | | |
| $x^* + \delta$ | --- | | 54.22 | | 54.06 | | 53.97 | | 53.94 | | 53.92 | | 53.91 | | |
| Lab EX8 | 49 | 3.00 | 49.78 | 6.44 | 50.56 | 3.13 | 50.69 | 2.68 | 50.72 | 2.58 | 50.73 | 2.54 | 50.74 | 2.52 | -3.15 |
| Lab 2 | 51 | 1.00 | 51.00 | 1.72 | 51.00 | 1.77 | 51.00 | 1.77 | 51.00 | 1.76 | 51.00 | 1.76 | 51.00 | 1.75 | -1.26 |
| Lab 64 | 51 | 1.00 | 51.00 | 1.72 | 51.00 | 1.77 | 51.00 | 1.77 | 51.00 | 1.76 | 51.00 | 1.76 | 51.00 | 1.75 | -1.26 |
| Lab 7 | 51 | 1.00 | 51.00 | 1.72 | 51.00 | 1.77 | 51.00 | 1.77 | 51.00 | 1.76 | 51.00 | 1.76 | 51.00 | 1.75 | -1.26 |
| Lab 82 | 51 | 1.00 | 51.00 | 1.72 | 51.00 | 1.77 | 51.00 | 1.77 | 51.00 | 1.76 | 51.00 | 1.76 | 51.00 | 1.75 | -1.26 |
| Lab EX12 | 51 | 1.00 | 51.00 | 1.72 | 51.00 | 1.77 | 51.00 | 1.77 | 51.00 | 1.76 | 51.00 | 1.76 | 51.00 | 1.75 | -1.26 |
| Lab 28 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab 39 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab 67 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab 68 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab 72 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab 89 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab 9 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab EX14 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab EX3 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab EX4 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab EX5 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab EX6 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab G01 | 52 | 0.00 | 52.00 | 0.10 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | 52.00 | 0.11 | -0.31 |
| Lab 23 | 53 | 1.00 | 53.00 | 0.47 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.46 | 0.64 |
| Lab 35 | 53 | 1.00 | 53.00 | 0.47 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.46 | 0.64 |
| Lab 56 | 53 | 1.00 | 53.00 | 0.47 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.46 | 0.64 |
| Lab 58 | 53 | 1.00 | 53.00 | 0.47 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.46 | 0.64 |
| Lab 71 | 53 | 1.00 | 53.00 | 0.47 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.46 | 0.64 |
| Lab 74 | 53 | 1.00 | 53.00 | 0.47 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.46 | 0.64 |
| Lab 79 | 53 | 1.00 | 53.00 | 0.47 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.46 | 0.64 |
| Lab EX10 | 53 | 1.00 | 53.00 | 0.47 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.46 | 0.64 |
| Lab EX9 | 53 | 1.00 | 53.00 | 0.47 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.45 | 53.00 | 0.46 | 0.64 |
| Lab 21 | 54 | 2.00 | 54.00 | 2.85 | 54.00 | 2.78 | 53.97 | 2.69 | 53.94 | 2.60 | 53.92 | 2.55 | 53.91 | 2.52 | 1.59 |
| Lab 4 | 54 | 2.00 | 54.00 | 2.85 | 54.00 | 2.78 | 53.97 | 2.69 | 53.94 | 2.60 | 53.92 | 2.55 | 53.91 | 2.52 | 1.59 |
| Lab EX11 | 54 | 2.00 | 54.00 | 2.85 | 54.00 | 2.78 | 53.97 | 2.69 | 53.94 | 2.60 | 53.92 | 2.55 | 53.91 | 2.52 | 1.59 |
| Lab EX13 | 55 | 3.00 | 54.22 | 3.66 | 54.06 | 2.99 | 53.97 | 2.69 | 53.94 | 2.60 | 53.92 | 2.55 | 53.91 | 2.52 | 2.53 |
| Average | 52.31 | | 52.31 | 32.77 | 52.33 | 28.79 | 52.33 | 27.75 | 52.33 | 27.26 | 52.33 | 27.00 | 52.32 | 26.86 | |
| SD | 1.15 | | 1.03 | 1.06 | 0.96 | 0.93 | 0.95 | 0.90 | 0.94 | 0.88 | 0.93 | 0.87 | 0.93 | 0.87 | |
| New x* | 52 | 1.00 | 52.31 | 1.03 | 52.33 | 0.96 | 52.33 | 0.95 | 52.33 | 0.94 | 52.33 | 0.93 | 52.32 | 0.93 | |
| New s* | 1.48 | | 1.17 | | 1.09 | | 1.07 | | 1.06 | | 1.06 | | 1.06 | | |

N 32

Target value 52.32

Low Acceptable 49.16

High Acceptable 55.49

Acceptable Range 49.16 - 55.49

Determination of Liquid Limit, Plastic Limit, And Plasticity Index

Appendix B: Calculation of z-scores and other statistics

Table - 2 Plastic Limit %

| Iteration | 0 | xi-x* | 1 | (xi-x*) ² | 2 | (xi-x*) ² | 3 | (xi-x*) ² | 4 | (xi-x*) ² | 5 | (xi-x*) ² | 6 | (xi-x*) ² | Z Score |
|--------------------|-------|-------|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|---------|
| $\delta = 1.5 s^*$ | --- | | 2.22 | | 1.85 | | 1.83 | | 1.82 | | 1.82 | | 1.82 | | |
| $x^* - \delta$ | --- | | 21.78 | | 22.48 | | 22.49 | | 22.50 | | 22.50 | | 22.50 | | |
| $x^* + \delta$ | --- | | 26.22 | | 26.17 | | 26.15 | | 26.14 | | 26.14 | | 26.14 | | |
| Lab 21 | 23 | 1.00 | 23.00 | 1.76 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | -1.09 |
| Lab 39 | 23 | 1.00 | 23.00 | 1.76 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | -1.09 |
| Lab 56 | 23 | 1.00 | 23.00 | 1.76 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | -1.09 |
| Lab 67 | 23 | 1.00 | 23.00 | 1.76 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | -1.09 |
| Lab 74 | 23 | 1.00 | 23.00 | 1.76 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | -1.09 |
| Lab 9 | 23 | 1.00 | 23.00 | 1.76 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | -1.09 |
| Lab EX11 | 23 | 1.00 | 23.00 | 1.76 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | -1.09 |
| Lab EX14 | 23 | 1.00 | 23.00 | 1.76 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | -1.09 |
| Lab EX6 | 23 | 1.00 | 23.00 | 1.76 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | 23.00 | 1.75 | -1.09 |
| Lab 2 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab 23 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab 35 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab 4 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab 58 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab 7 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab 71 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab 79 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab 82 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab EX9 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab G01 | 24 | 0.00 | 24.00 | 0.11 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | 24.00 | 0.10 | -0.26 |
| Lab 89 | 25 | 1.00 | 25.00 | 0.45 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 0.56 |
| Lab EX10 | 25 | 1.00 | 25.00 | 0.45 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 0.56 |
| Lab EX3 | 25 | 1.00 | 25.00 | 0.45 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 0.56 |
| Lab EX5 | 25 | 1.00 | 25.00 | 0.45 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 0.56 |
| Lab EX8 | 25 | 1.00 | 25.00 | 0.45 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 25.00 | 0.46 | 0.56 |
| Lab 28 | 26 | 2.00 | 26.00 | 2.80 | 26.00 | 2.81 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 1.38 |
| Lab 64 | 26 | 2.00 | 26.00 | 2.80 | 26.00 | 2.81 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 1.38 |
| Lab EX12 | 26 | 2.00 | 26.00 | 2.80 | 26.00 | 2.81 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 1.38 |
| Lab EX13 | 26 | 2.00 | 26.00 | 2.80 | 26.00 | 2.81 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 1.38 |
| Lab EX4 | 26 | 2.00 | 26.00 | 2.80 | 26.00 | 2.81 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 26.00 | 2.82 | 1.38 |
| Lab 72 | 27 | 3.00 | 26.22 | 3.60 | 26.17 | 3.42 | 26.15 | 3.35 | 26.14 | 3.32 | 26.14 | 3.32 | 26.14 | 3.31 | 2.21 |
| Lab 68 | 29 | 5.00 | 26.22 | 3.60 | 26.17 | 3.42 | 26.15 | 3.35 | 26.14 | 3.32 | 26.14 | 3.32 | 26.14 | 3.31 | 3.86 |
| Average | 24.44 | | 24.33 | 40.48 | 24.32 | 40.09 | 24.32 | 39.95 | 24.32 | 39.89 | 24.32 | 39.87 | 24.32 | 39.87 | |
| SD | 1.41 | | 1.14 | 1.18 | 1.14 | 1.16 | 1.14 | 1.15 | 1.13 | 1.15 | 1.13 | 1.14 | 1.13 | 1.14 | |
| New x* | 24 | 1.00 | 24.33 | 1.09 | 24.32 | 1.08 | 24.32 | 1.07 | 24.32 | 1.07 | 24.32 | 1.07 | 24.32 | 1.07 | |
| New s* | 1.48 | | 1.23 | | 1.22 | | 1.22 | | 1.21 | | 1.21 | | 1.21 | | |

N 32

Target value **24.32**

Low Acceptable **20.68**

High Acceptable **27.96**

Acceptable Range **20.68 - 27.96**

Determination of Liquid Limit, Plastic Limit, And Plasticity Index

Appendix B: Calculation of z-scores and other statistics

Table - 3 Plasticity Index %

| Iteration | 0 | xi-x* | 1 | (xi-x*) ² | 2 | (xi-x*) ² | 3 | (xi-x*) ² | 4 | (xi-x*) ² | 5 | (xi-x*) ² | 6 | (xi-x*) ² | Z Score |
|--------------------|-------|-------|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|-------|----------------------|---------|
| $\delta = 1.5 s^*$ | --- | | 2.22 | | 2.24 | | 1.93 | | 1.76 | | 1.69 | | 1.62 | | |
| $x^* - \delta$ | --- | | 26.78 | | 26.06 | | 26.33 | | 26.48 | | 26.54 | | 26.60 | | |
| $x^* + \delta$ | --- | | 31.22 | | 30.53 | | 30.20 | | 30.01 | | 29.92 | | 29.84 | | |
| Lab 68 | 23 | 6.00 | 26.78 | 2.31 | 26.78 | 2.22 | 26.78 | 2.16 | 26.78 | 2.12 | 26.78 | 2.09 | 26.78 | 2.05 | -5.01 |
| Lab EX8 | 24 | 5.00 | 26.78 | 2.31 | 26.78 | 2.22 | 26.78 | 2.16 | 26.78 | 2.12 | 26.78 | 2.09 | 26.78 | 2.05 | -4.04 |
| Lab 64 | 25 | 4.00 | 26.78 | 2.31 | 26.78 | 2.22 | 26.78 | 2.16 | 26.78 | 2.12 | 26.78 | 2.09 | 26.78 | 2.05 | -3.08 |
| Lab 72 | 25 | 4.00 | 26.78 | 2.31 | 26.78 | 2.22 | 26.78 | 2.16 | 26.78 | 2.12 | 26.78 | 2.09 | 26.78 | 2.05 | -3.08 |
| Lab EX12 | 25 | 4.00 | 26.78 | 2.31 | 26.78 | 2.22 | 26.78 | 2.16 | 26.78 | 2.12 | 26.78 | 2.09 | 26.78 | 2.05 | -3.08 |
| Lab 28 | 26 | 3.00 | 26.78 | 2.31 | 26.78 | 2.22 | 26.78 | 2.16 | 26.78 | 2.12 | 26.78 | 2.09 | 26.78 | 2.05 | -2.12 |
| Lab EX4 | 26 | 3.00 | 26.78 | 2.31 | 26.78 | 2.22 | 26.78 | 2.16 | 26.78 | 2.12 | 26.78 | 2.09 | 26.78 | 2.05 | -2.12 |
| Lab 2 | 27 | 2.00 | 27.00 | 1.68 | 27.00 | 1.60 | 27.00 | 1.55 | 27.00 | 1.52 | 27.00 | 1.49 | 27.00 | 1.46 | -1.16 |
| Lab 7 | 27 | 2.00 | 27.00 | 1.68 | 27.00 | 1.60 | 27.00 | 1.55 | 27.00 | 1.52 | 27.00 | 1.49 | 27.00 | 1.46 | -1.16 |
| Lab 82 | 27 | 2.00 | 27.00 | 1.68 | 27.00 | 1.60 | 27.00 | 1.55 | 27.00 | 1.52 | 27.00 | 1.49 | 27.00 | 1.46 | -1.16 |
| Lab 89 | 27 | 2.00 | 27.00 | 1.68 | 27.00 | 1.60 | 27.00 | 1.55 | 27.00 | 1.52 | 27.00 | 1.49 | 27.00 | 1.46 | -1.16 |
| Lab EX3 | 27 | 2.00 | 27.00 | 1.68 | 27.00 | 1.60 | 27.00 | 1.55 | 27.00 | 1.52 | 27.00 | 1.49 | 27.00 | 1.46 | -1.16 |
| Lab EX5 | 27 | 2.00 | 27.00 | 1.68 | 27.00 | 1.60 | 27.00 | 1.55 | 27.00 | 1.52 | 27.00 | 1.49 | 27.00 | 1.46 | -1.16 |
| Lab EX10 | 28 | 1.00 | 28.00 | 0.09 | 28.00 | 0.07 | 28.00 | 0.06 | 28.00 | 0.05 | 28.00 | 0.05 | 28.00 | 0.04 | -0.20 |
| Lab G01 | 28 | 1.00 | 28.00 | 0.09 | 28.00 | 0.07 | 28.00 | 0.06 | 28.00 | 0.05 | 28.00 | 0.05 | 28.00 | 0.04 | -0.20 |
| Lab 23 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab 35 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab 39 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab 58 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab 67 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab 71 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab 79 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab 9 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab EX13 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab EX14 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab EX6 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab EX9 | 29 | 0.00 | 29.00 | 0.50 | 29.00 | 0.54 | 29.00 | 0.57 | 29.00 | 0.59 | 29.00 | 0.61 | 29.00 | 0.63 | 0.76 |
| Lab 4 | 30 | 1.00 | 30.00 | 2.91 | 30.00 | 3.01 | 30.00 | 3.08 | 30.00 | 3.12 | 29.92 | 2.90 | 29.84 | 2.68 | 1.72 |
| Lab 56 | 30 | 1.00 | 30.00 | 2.91 | 30.00 | 3.01 | 30.00 | 3.08 | 30.00 | 3.12 | 29.92 | 2.90 | 29.84 | 2.68 | 1.72 |
| Lab 74 | 30 | 1.00 | 30.00 | 2.91 | 30.00 | 3.01 | 30.00 | 3.08 | 30.00 | 3.12 | 29.92 | 2.90 | 29.84 | 2.68 | 1.72 |
| Lab 21 | 31 | 2.00 | 31.00 | 7.32 | 30.53 | 5.13 | 30.20 | 3.82 | 30.01 | 3.15 | 29.92 | 2.90 | 29.84 | 2.68 | 2.68 |
| Lab EX11 | 31 | 2.00 | 31.00 | 7.32 | 30.53 | 5.13 | 30.20 | 3.82 | 30.01 | 3.15 | 29.92 | 2.90 | 29.84 | 2.68 | 2.68 |
| Average | 27.88 | | 28.29 | 55.72 | 28.27 | 51.05 | 28.24 | 48.25 | 28.23 | 46.83 | 28.22 | 45.43 | 28.21 | 44.11 | |
| SD | 2.00 | | 1.34 | 1.73 | 1.28 | 1.29 | 1.25 | 1.08 | 1.23 | 0.99 | 1.21 | 0.91 | 1.19 | 0.84 | |
| New x* | 29 | 1.00 | 28.29 | 1.31 | 28.27 | 1.14 | 28.24 | 1.04 | 28.23 | 0.99 | 28.22 | 0.95 | 28.21 | 0.92 | |
| New s* | 1.48 | | 1.49 | | 1.29 | | 1.18 | | 1.13 | | 1.08 | | 1.04 | | |

N 32

Target value 28.21

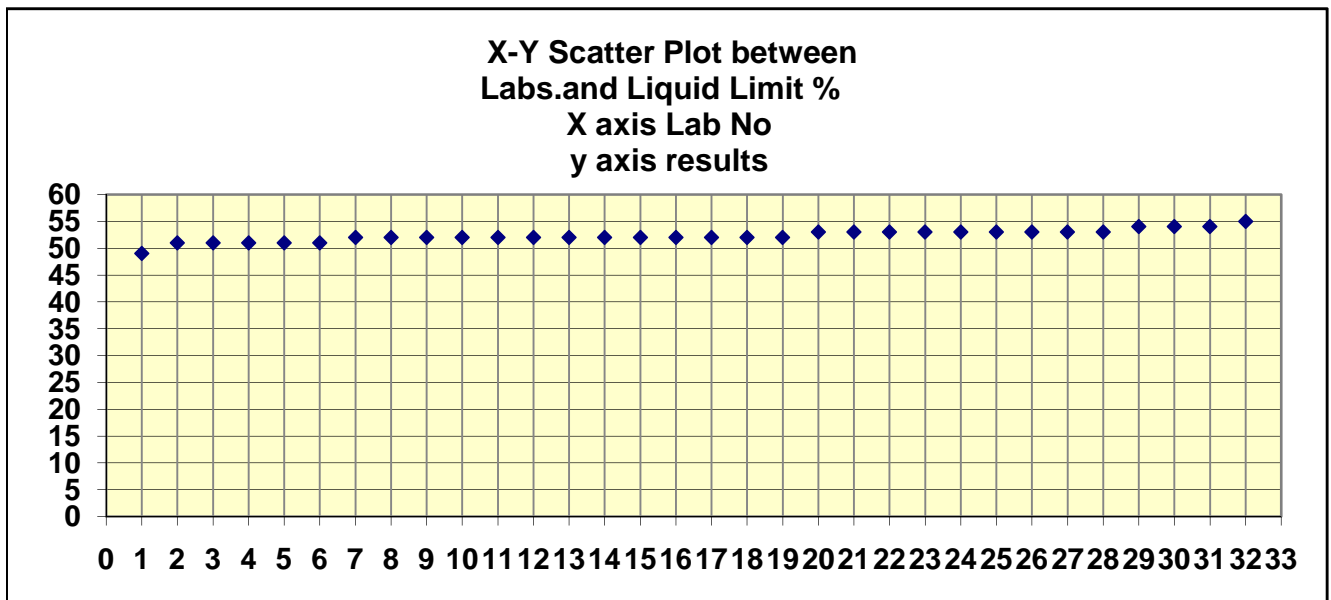
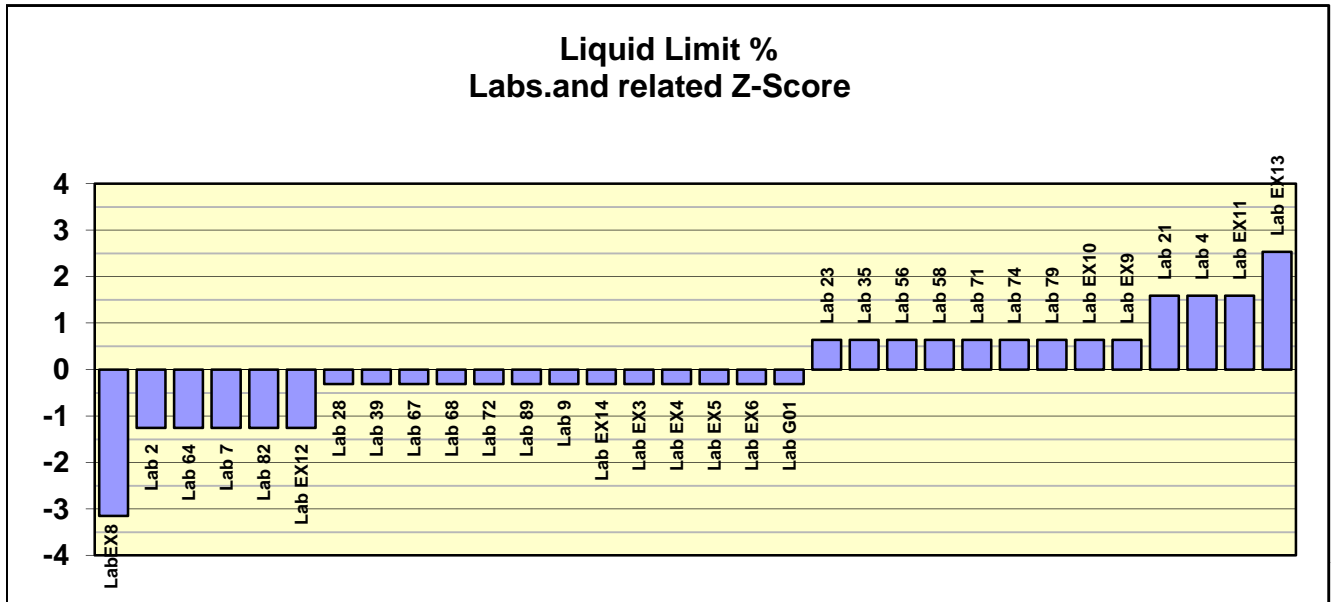
Low Acceptable 25.09

High Acceptable 31.33

Acceptable Range 25.09 - 31.33

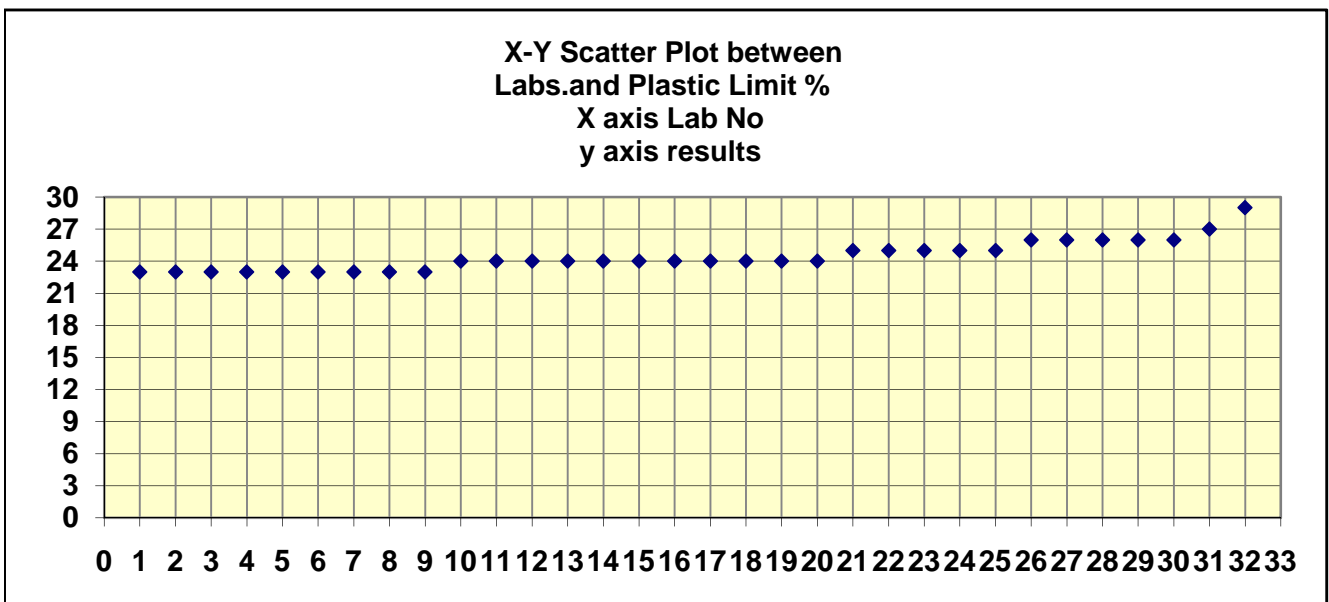
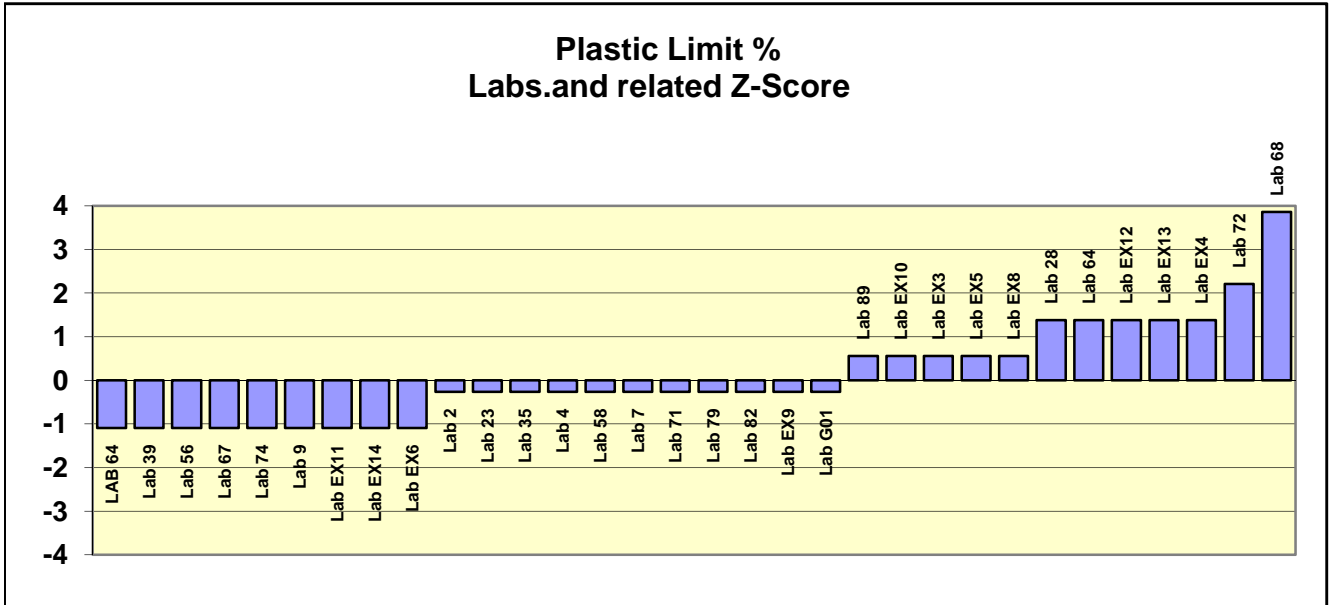
Determination of Liquid Limit, Plastic Limit, And Plasticity Index

Appendix C:Charts



Determination of Liquid Limit, Plastic Limit, And Plasticity Index

Appendix C:Charts



Determination of Liquid Limit, Plastic Limit, And Plasticity Index

Appendix C:Charts

