



REF: 812/02/02/1/546

DATE: 19 JULY 2006

ATTENTION: LAB MANAGER

SUBJECT: 140th INTER-LABORATORY PROFICIENCY TESTING PROGRAM

We are pleased to present the results of the 140th Inter-laboratory Proficiency Testing Program involving the Determination of Particle Size Distribution & Specific Gravity and Absorption.

As in previous programs, we have assigned code numbers to participating laboratories in order to protect their identities. For this particular program please contact Dr. Yaser (Tel. No. 3027074) or Ms. Fatima (Tel. No. 3027071) to inform you which code number has been assigned to you.

You are also requested to pay to Dubai Accreditation Centre (DAC), an amount of (Dhs 418) in return for your participation in the Inter-laboratory Proficiency Testing Program (please note that the governmental laboratories are exempted from participation fees). We would like to draw your attention that payment can be made through DCLD counter- ground floor by credit card. Should you intend to pay by cheque please address the cheque to Dubai Municipality. After payment, please submit a copy of the invoice to the Accreditation Center (Ms. Fatima in the administration building on the second floor office no. 314B).

You are kindly requested to pay the amount within one month from the date in which the result is posted on our website.

We thank you for your participation and we would welcome any comments or suggestions on this and on future programs. Please do not hesitate to contact us if you need any clarification on the report.

*Kind Regards***ENG. LINA QUDAH****HEAD OF ACCREDITATION DECISIONS SECTION-DAC**

رؤيتنا: بناء مدينة متميزة تتوفر فيها رفاهية العيش ومقومات النجاح

Our Vision : To create an excellent city that provides the essence of success and comfort of living



DUBAI ACCREDITATION CENTER

Report on 140th Inter-Laboratory Proficiency Testing Determination of Particle Size Distribution & Specific Gravity and Absorption

Date: 22 July 2006

1. INTRODUCTION

This document presents the results of the 140th inter-laboratory proficiency-testing program conducted during the months of May and June 2006, according to BS EN 933-1: 1997: and ASTM C128: 2004.

This program is part of the Interlaboratory Comparison Programs organized by Dubai Accreditation Center of 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 Participants:

A total of fourteen laboratories participated in this program.

2.2 Samples tested:

Four (4) samples consisted of crushed rock sand, approximately 5 Kg each in plastic bags, are distributed to all participating laboratories.

From one portion, 28 test samples were randomly selected and similarly from the other portion, another 28 test samples were also selected. The test samples were randomly assigned to the fourteenth participating laboratories with each participant being assigned four test bags, two from each side. The test samples were designated as Samples 1 to 4 with a unique identification number marked on each test sample.

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

- 4.1 Instructions were given to the participants to test the samples as per BS EN 933-1:1997 (Seive size to be used in mm: 10, 5, 2.36, 1.18, 0.600, 0.300, 0.150 &0.075),
- 4.2 Specific Gravity and Absorption of Fine Aggregate as per ASTM C128: 2004.



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5. TEST RESULTS

Test results submitted by the participating laboratories are presented in Appendix A. The numbers in the column headings of the table represent the code numbers of the participating laboratories.

6. EVALUATION OF RESULTS

6.1 Please refer to the document **DAC-G3-03** Robust Z-Score Analysis for the methodologies of analysis.

6.2 Calculations of z-scores from the results

Appendix B gives the details of the calculation of the Z-Score. The Z score analysis is based on an internationally accepted procedure being used by accreditation bodies implementing Interlaboratory comparison programs.

6.3 Outlier results

After evaluating the Z-Score, the following results were considered outliers:

| Test Parameter | Labs with outlier results | Type of Outlier |
|--|--|-----------------|
| Particle Size Distribution 0.300 mm | Lab 3-2 Lab 8-2 Lab 9-1 Lab 9-2 | Between labs |
| | Lab 6-1 Lab 9-1 | Within labs |
| Particle Size Distribution 0.075 mm | Lab 9-1 | Within labs |
| Relative Density (OD) | Lab 8-1 Lab 8-2 Lab 9-1 Lab 9-2 | Between labs |
| Relative Density (SSD) | Lab 1-1 | Within labs |
| | Lab 9-1 Lab 9-2 | Between labs |



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| Test Parameter | Labs with outlier results | Type of Outlier |
|---------------------------|--|-----------------|
| Apparent Relative Density | Lab 9-1 Lab9-2 | Between labs |
| | Lab 1-1 Lab1-2 | Within labs |
| Water Absorption | Lab 8-1 Lab 8-2 Lab 12-1 Lab 12-2 | Between labs |

The test results provided by the abovementioned laboratories are outside the Z score limits of ± 3 , the abovementioned laboratories are requested to investigate the root cause of the outlier results, implement corrective action and email a report within 2 weeks to Accreditation Decisions Section of the Dubai Accreditation Center to the following address lmqudah@dm.gov.ae.

7. APPENDICES

- 7.1 Appendix A: Raw Data
- 7.2 Appendix B: Calculation of z-scores and other statistics
- 7.3 Appendix C: Charts

Appendix A: Raw results

Table 1: Summary of results for Sample 1

| Participant Labs. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|-------------------|----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Grading | 0.300 mm | 14.0 | 16.0 | 15.0 | 15.0 | 16.0 | 14.0 | 14.0 | 15.0 | 15.0 | 15.0 | 15.0 | 14.0 | 15 | 15 |
| | 0.150 mm | 10.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 10.0 | 10.0 | 10.0 | 10.0 | 11.0 | 9.0 | 10 | 11 |
| | 0.075 mm | 7.0 | 8.1 | 8.0 | 8.0 | 8.0 | 8.1 | 7.0 | 8.0 | 8.4 | 8.0 | 8.0 | 7.0 | 8 | 8 |
| Rel Den. (OD) | | 2.70 | 2.69 | 2.70 | 2.70 | 2.70 | 2.70 | 2.71 | 2.74 | 2.80 | 2.69 | 2.71 | 2.73 | 2.68 | 2.7 |
| Rel Den (SSD) | | 2.75 | 2.72 | 2.73 | 2.73 | 2.73 | 2.73 | 2.73 | 2.77 | 2.84 | 2.73 | 2.74 | 2.76 | 2.72 | 2.73 |
| App Rel Den | | 2.81 | 2.78 | 2.79 | 2.79 | 2.79 | 2.79 | 2.78 | 2.81 | 2.90 | 2.79 | 2.79 | 2.80 | 2.79 | 2.79 |
| Water Absorption | | 1.1 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.0 | 0.8 | 1.2 | 1.2 | 1.2 | 0.9 | 1.5 | 1.2 |

Table 2: Summary of results for Sample 2

| Participant Labs. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|-------------------|----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Grading | 0.300 mm | 15.0 | 14.0 | 16.0 | 15.0 | 16.0 | 15.0 | 14.0 | 14.0 | 13.0 | 14.0 | 15.0 | 15.0 | 15 | 15 |
| | 0.150 mm | 11.0 | 10.0 | 12.0 | 10.0 | 11.0 | 11.0 | 10.0 | 10.0 | 9.7 | 10.0 | 10.0 | 10.0 | 10 | 10 |
| | 0.075 mm | 8.0 | 7.5 | 9.0 | 8.0 | 8.0 | 6.0 | 7.0 | 7.0 | 8.1 | 8.0 | 8.0 | 8.0 | 8 | 8 |
| Rel Den. (OD) | | 2.72 | 2.67 | 2.70 | 2.71 | 2.70 | 2.71 | 2.71 | 2.74 | 2.79 | 2.70 | 2.72 | 2.72 | 2.68 | 2.7 |
| Rel Den (SSD) | | 2.76 | 2.70 | 2.74 | 2.74 | 2.73 | 2.74 | 2.74 | 2.76 | 2.82 | 2.74 | 2.74 | 2.75 | 2.72 | 2.73 |
| App Rel Den | | 2.82 | 2.78 | 2.79 | 2.80 | 2.79 | 2.80 | 2.79 | 2.80 | 2.89 | 2.80 | 2.80 | 2.80 | 2.79 | 2.79 |
| Water Absorption | | 1.1 | 1.4 | 1.2 | 1.2 | 1.2 | 1.2 | 1.0 | 0.8 | 1.2 | 1.2 | 1.2 | 1.0 | 1.5 | 1.2 |

Appendix A: Raw results

Table 3: Summary of results for Sample 3

| Participant Labs. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|-------------------|----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Grading | 0.300 mm | 25.0 | 26.0 | 26.0 | 25.0 | 25.0 | 27.0 | 25.0 | 24.0 | 22.0 | 25.0 | 25.0 | 25.0 | 26 | 24 |
| | 0.150 mm | 18.0 | 18.0 | 18.0 | 18.0 | 17.0 | 20.0 | 19.0 | 16.0 | 15.0 | 18.0 | 18.0 | 18.0 | 18 | 17 |
| | 0.075 mm | 12.0 | 12.9 | 13.0 | 12.0 | 12.0 | 14.0 | 12.0 | 11.0 | 11.0 | 13.0 | 12.0 | 12.0 | 13 | 12 |
| Rel Den. (OD) | | 2.81 | 2.78 | 2.85 | 2.84 | 2.81 | 2.83 | 2.82 | 2.89 | 2.94 | 2.84 | 2.84 | 2.86 | 2.83 | 2.84 |
| Rel Den (SSD) | | 2.84 | 2.82 | 2.88 | 2.88 | 2.86 | 2.86 | 2.86 | 2.91 | 2.98 | 2.88 | 2.88 | 2.88 | 2.87 | 2.88 |
| App Rel Den | | 2.92 | 2.92 | 2.94 | 2.96 | 2.94 | 2.92 | 2.93 | 2.95 | 3.06 | 2.94 | 2.93 | 2.93 | 2.94 | 2.95 |
| Water Absorption | | 1.4 | 1.7 | 1.0 | 1.3 | 1.5 | 1.1 | 1.3 | 0.6 | 1.3 | 1.3 | 1.1 | 0.8 | 1.3 | 1.4 |

Table 4: Summary of results for Sample 4

| Participant Labs. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|-------------------|----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Grading | 0.300 mm | 25.0 | 26.0 | 27.0 | 25.0 | 24.0 | 25.0 | 24.0 | 23.0 | 21.0 | 24.0 | 25.0 | 25.0 | 26 | 25 |
| | 0.150 mm | 18.0 | 18.0 | 19.0 | 17.0 | 17.0 | 17.0 | 18.0 | 16.0 | 14.0 | 17.0 | 18.0 | 17.0 | 18 | 17 |
| | 0.075 mm | 13.0 | 12.9 | 14.0 | 12.0 | 12.0 | 12.0 | 12.0 | 11.0 | 11.0 | 12 | 13.0 | 12.0 | 13 | 12 |
| Rel Den. (OD) | | 2.84 | 2.80 | 2.85 | 2.82 | 2.81 | 2.84 | 2.83 | 2.89 | 2.94 | 2.85 | 2.86 | 2.87 | 2.84 | 2.84 |
| Rel Den (SSD) | | 2.87 | 2.84 | 2.88 | 2.88 | 2.86 | 2.88 | 2.87 | 2.91 | 2.98 | 2.87 | 2.90 | 2.89 | 2.87 | 2.88 |
| App Rel Den | | 2.94 | 2.93 | 2.93 | 2.95 | 2.94 | 2.95 | 2.94 | 2.94 | 3.06 | 2.95 | 2.94 | 2.93 | 2.94 | 2.95 |
| Water Absorption | | 1.3 | 1.6 | 1.0 | 1.3 | 1.5 | 1.3 | 1.3 | 0.6 | 1.3 | 1.4 | 1.1 | 0.7 | 1.3 | 1.4 |

Table 1: Particle size distribution, 0.300 mm

| Lab# | S1 S2 | S3 S4 | Between Labs S1+S3 S2+S4 | Within Labs S1-S3 S2-S4 | Between Labs z-score | Within Labs z-score |
|---------|----------|----------|-----------------------------------|----------------------------------|----------------------------|---------------------------|
| Lab1-1 | 14 | 25 | 39 | -11 | -1.0792 | -1.0792 |
| Lab1-2 | 15 | 25 | 40 | -10 | 0.0000 | 0.0000 |
| Lab2-1 | 16 | 26 | 42 | -10 | 2.1584 | 0.0000 |
| Lab2-2 | 14 | 26 | 40 | -12 | 0.0000 | -2.1584 |
| Lab3-1 | 15 | 26 | 41 | -11 | 1.0792 | -1.0792 |
| Lab3-2 | 16 | 27 | 43 | -11 | 3.2376 | -1.0792 |
| Lab4-1 | 15 | 25 | 40 | -10 | 0.0000 | 0.0000 |
| Lab4-2 | 15 | 25 | 40 | -10 | 0.0000 | 0.0000 |
| Lab5-1 | 16 | 25 | 41 | -9 | 1.0792 | 1.0792 |
| Lab5-2 | 16 | 24 | 40 | -8 | 0.0000 | 2.1584 |
| Lab6-1 | 14 | 27 | 41 | -13 | 1.0792 | -3.2376 |
| Lab6-2 | 15 | 25 | 40 | -10 | 0.0000 | 0.0000 |
| Lab7-1 | 14 | 25 | 39 | -11 | -1.0792 | -1.0792 |
| Lab7-2 | 14 | 24 | 38 | -10 | -2.1584 | 0.0000 |
| Lab8-1 | 15 | 24 | 39 | -9 | -1.0792 | 1.0792 |
| Lab8-2 | 14 | 23 | 37 | -9 | -3.2376 | 1.0792 |
| Lab9-1 | 15 | 22 | 37 | -7 | -3.2376 | 3.2376 |
| Lab9-2 | 13 | 21 | 34 | -8 | -6.4751 | 2.1584 |
| Lab10-1 | 15 | 25 | 40 | -10 | 0.0000 | 0.0000 |
| Lab10-2 | 14 | 24 | 38 | -10 | -2.1584 | 0.0000 |
| Lab11-1 | 15 | 25 | 40 | -10 | 0.0000 | 0.0000 |
| Lab11-2 | 15 | 25 | 40 | -10 | 0.0000 | 0.0000 |
| Lab12-1 | 14 | 25 | 39 | -11 | -1.0792 | -1.0792 |
| Lab12-2 | 15 | 25 | 40 | -10 | 0.0000 | 0.0000 |
| Lab13-1 | 15 | 26 | 41 | -11 | 1.0792 | -1.0792 |
| Lab13-2 | 15 | 26 | 41 | -11 | 1.0792 | -1.0792 |
| Lab14-1 | 15 | 24 | 39 | -9 | -1.0792 | 1.0792 |
| Lab14-2 | 15 | 25 | 40 | -10 | 0.0000 | 0.0000 |

| | | | | |
|----------------|------|------|------|-------|
| No. of Results | 28 | 28 | 28 | 28 |
| Median | 15.0 | 25.0 | 40.0 | -10.0 |
| Q 1 | 14.0 | 24.0 | 39.0 | -11.0 |
| Q 3 | 15.0 | 25.3 | 40.3 | -9.8 |
| Inter Q Range | 1.00 | 1.25 | 1.25 | 1.25 |
| Normalzd IQR | 0.74 | 0.93 | 0.93 | 0.93 |
| Robust CV,% | 4.9 | 3.7 | 2.3 | -9.3 |
| Minimum | 13 | 21 | 34 | -13 |
| Maximum | 16 | 27 | 43 | -7 |
| Range | 3 | 6 | 9 | 6 |

Table 2: Particle size distribution, 0.150 mm

| Lab# | S1 S2 | S3 S4 | Between Labs S1+S3 S2+S4 | Within Labs S1-S3 S2-S4 | Between Labs z-score | Within Labs z-score |
|---------|----------|----------|-----------------------------------|----------------------------------|----------------------------|---------------------------|
| Lab1-1 | 10 | 18 | 28 | -8 | 0.0000 | -0.6745 |
| Lab1-2 | 11 | 18 | 29 | -7 | 0.6745 | 0.0000 |
| Lab2-1 | 11 | 18 | 29 | -7 | 0.6745 | 0.0000 |
| Lab2-2 | 10 | 18 | 28 | -8 | 0.0000 | -0.6745 |
| Lab3-1 | 11 | 18 | 29 | -7 | 0.6745 | 0.0000 |
| Lab3-2 | 12 | 19 | 31 | -7 | 2.0235 | 0.0000 |
| Lab4-1 | 11 | 18 | 29 | -7 | 0.6745 | 0.0000 |
| Lab4-2 | 10 | 17 | 27 | -7 | -0.6745 | 0.0000 |
| Lab5-1 | 11 | 17 | 28 | -6 | 0.0000 | 0.6745 |
| Lab5-2 | 11 | 17 | 28 | -6 | 0.0000 | 0.6745 |
| Lab6-1 | 11 | 20 | 31 | -9 | 2.0235 | -1.3490 |
| Lab6-2 | 11 | 17 | 28 | -6 | 0.0000 | 0.6745 |
| Lab7-1 | 10 | 19 | 29 | -9 | 0.6745 | -1.3490 |
| Lab7-2 | 10 | 18 | 28 | -8 | 0.0000 | -0.6745 |
| Lab8-1 | 10 | 16 | 26 | -6 | -1.3490 | 0.6745 |
| Lab8-2 | 10 | 16 | 26 | -6 | -1.3490 | 0.6745 |
| Lab9-1 | 10 | 15 | 25 | -5 | -2.0235 | 1.3490 |
| Lab9-2 | 9.7 | 14 | 23.7 | -4.3 | -2.9003 | 1.8211 |
| Lab10-1 | 10 | 18 | 28 | -8 | 0.0000 | -0.6745 |
| Lab10-2 | 10 | 17 | 27 | -7 | -0.6745 | 0.0000 |
| Lab11-1 | 11 | 18 | 29 | -7 | 0.6745 | 0.0000 |
| Lab11-2 | 10 | 18 | 28 | -8 | 0.0000 | -0.6745 |
| Lab12-1 | 9 | 18 | 27 | -9 | -0.6745 | -1.3490 |
| Lab12-2 | 10 | 17 | 27 | -7 | -0.6745 | 0.0000 |
| Lab13-1 | 10 | 18 | 28 | -8 | 0.0000 | -0.6745 |
| Lab13-2 | 10 | 18 | 28 | -8 | 0.0000 | -0.6745 |
| Lab14-1 | 11 | 17 | 28 | -6 | 0.0000 | 0.6745 |
| Lab14-2 | 10 | 17 | 27 | -7 | -0.6745 | 0.0000 |

| | | | | |
|-----------------------|------|------|------|-------|
| No. of Results | 28 | 28 | 28 | 28 |
| Median | 10.0 | 18.0 | 28.0 | -7.0 |
| Q 1 | 10.0 | 17.0 | 27.0 | -8.0 |
| Q 3 | 11.0 | 18.0 | 29.0 | -6.0 |
| Inter Q Range | 1.00 | 1.00 | 2.00 | 2.00 |
| Normalzd IQR | 0.74 | 0.74 | 1.48 | 1.48 |
| Robust CV,% | 7.4 | 4.1 | 5.3 | -21.2 |
| Minimum | 9 | 14 | 23.7 | -9 |
| Maximum | 12 | 20 | 31 | -4.3 |
| Range | 3 | 6 | 7.3 | 4.7 |

Table 3: Particle size distribution, 0.075 mm

| Lab# | S1 S2 | S3 S4 | Between Labs S1+S3 S2+S4 | Within Labs S1-S3 S2-S4 | Between Labs z-score | Within Labs z-score |
|---------|----------|----------|-----------------------------------|----------------------------------|----------------------------|---------------------------|
| Lab1-1 | 7 | 12 | 19 | -5 | -0.7008 | -0.1349 |
| Lab1-2 | 8 | 13 | 21 | -5 | 0.7008 | -0.1349 |
| Lab2-1 | 8.1 | 12.9 | 21 | -4.8 | 0.7008 | 0.1349 |
| Lab2-2 | 7.5 | 12.9 | 20.4 | -5.4 | 0.2803 | -0.6745 |
| Lab3-1 | 8 | 13 | 21 | -5 | 0.7008 | -0.1349 |
| Lab3-2 | 9 | 14 | 23 | -5 | 2.1023 | -0.1349 |
| Lab4-1 | 8 | 12 | 20 | -4 | 0.0000 | 1.2141 |
| Lab4-2 | 8 | 12 | 20 | -4 | 0.0000 | 1.2141 |
| Lab5-1 | 8 | 12 | 20 | -4 | 0.0000 | 1.2141 |
| Lab5-2 | 8 | 12 | 20 | -4 | 0.0000 | 1.2141 |
| Lab6-1 | 8.1 | 14 | 22.1 | -5.9 | 1.4716 | -1.3490 |
| Lab6-2 | 6 | 12 | 18 | -6 | -1.4015 | -1.4839 |
| Lab7-1 | 7 | 12 | 19 | -5 | -0.7008 | -0.1349 |
| Lab7-2 | 7 | 12 | 19 | -5 | -0.7008 | -0.1349 |
| Lab8-1 | 8 | 11 | 19 | -3 | -0.7008 | 2.5631 |
| Lab8-2 | 7 | 11 | 18 | -4 | -1.4015 | 1.2141 |
| Lab9-1 | 8.4 | 11 | 19.4 | -2.6 | -0.4205 | 3.1027 |
| Lab9-2 | 8.1 | 11 | 19.1 | -2.9 | -0.6307 | 2.6980 |
| Lab10-1 | 8 | 13 | 21 | -5 | 0.7008 | -0.1349 |
| Lab10-2 | 8 | 12 | 20 | -4 | 0.0000 | 1.2141 |
| Lab11-1 | 8 | 12 | 20 | -4 | 0.0000 | 1.2141 |
| Lab11-2 | 8 | 13 | 21 | -5 | 0.7008 | -0.1349 |
| Lab12-1 | 7 | 12 | 19 | -5 | -0.7008 | -0.1349 |
| Lab12-2 | 8 | 12 | 20 | -4 | 0.0000 | 1.2141 |
| Lab13-1 | 8 | 13 | 21 | -5 | 0.7008 | -0.1349 |
| Lab13-2 | 8 | 13 | 21 | -5 | 0.7008 | -0.1349 |
| Lab14-1 | 8 | 12 | 20 | -4 | 0.0000 | 1.2141 |
| Lab14-2 | 8 | 12 | 20 | -4 | 0.0000 | 1.2141 |

| | | | | |
|----------------|------|------|------|-------|
| No. of Results | 28 | 28 | 28 | 28 |
| Median | 8.0 | 12.0 | 20.0 | -4.9 |
| Q 1 | 7.9 | 12.0 | 19.1 | -5.0 |
| Q 3 | 8.0 | 13.0 | 21.0 | -4.0 |
| Inter Q Range | 0.13 | 1.00 | 1.93 | 1.00 |
| Normalzd IQR | 0.09 | 0.74 | 1.43 | 0.74 |
| Robust CV,% | 1.2 | 6.2 | 7.1 | -15.1 |
| Minimum | 6 | 11 | 18 | -6 |
| Maximum | 9 | 14 | 23 | -2.6 |
| Range | 3 | 3 | 5 | 3.4 |

Table 4: Relative Density (O.D.)

| Lab# | S1 S2 | S3 S4 | Between Labs S1+S3 S2+S4 | Within Labs S1-S3 S2-S4 | Between Labs z-score | Within Labs z-score |
|---------|----------|----------|-----------------------------------|----------------------------------|----------------------------|---------------------------|
| Lab1-1 | 2.7 | 2.81 | 5.51 | -0.11 | -1.0792 | 1.3490 |
| Lab1-2 | 2.72 | 2.84 | 5.56 | -0.12 | 0.7195 | 0.8993 |
| Lab2-1 | 2.69 | 2.78 | 5.47 | -0.09 | -2.5181 | 2.2483 |
| Lab2-2 | 2.67 | 2.8 | 5.47 | -0.13 | -2.5181 | 0.4497 |
| Lab3-1 | 2.7 | 2.85 | 5.55 | -0.15 | 0.3597 | -0.4497 |
| Lab3-2 | 2.7 | 2.85 | 5.55 | -0.15 | 0.3597 | -0.4497 |
| Lab4-1 | 2.7 | 2.84 | 5.54 | -0.14 | 0.0000 | 0.0000 |
| Lab4-2 | 2.71 | 2.82 | 5.53 | -0.11 | -0.3597 | 1.3490 |
| Lab5-1 | 2.7 | 2.81 | 5.51 | -0.11 | -1.0792 | 1.3490 |
| Lab5-2 | 2.7 | 2.81 | 5.51 | -0.11 | -1.0792 | 1.3490 |
| Lab6-1 | 2.7 | 2.83 | 5.53 | -0.13 | -0.3597 | 0.4497 |
| Lab6-2 | 2.71 | 2.84 | 5.55 | -0.13 | 0.3597 | 0.4497 |
| Lab7-1 | 2.71 | 2.82 | 5.53 | -0.11 | -0.3597 | 1.3490 |
| Lab7-2 | 2.71 | 2.83 | 5.54 | -0.12 | 0.0000 | 0.8993 |
| Lab8-1 | 2.74 | 2.89 | 5.63 | -0.15 | 3.2376 | -0.4497 |
| Lab8-2 | 2.74 | 2.89 | 5.63 | -0.15 | 3.2376 | -0.4497 |
| Lab9-1 | 2.8 | 2.94 | 5.74 | -0.14 | 7.1946 | 0.0000 |
| Lab9-2 | 2.79 | 2.94 | 5.73 | -0.15 | 6.8348 | -0.4497 |
| Lab10-1 | 2.69 | 2.84 | 5.53 | -0.15 | -0.3597 | -0.4497 |
| Lab10-2 | 2.7 | 2.85 | 5.55 | -0.15 | 0.3597 | -0.4497 |
| Lab11-1 | 2.71 | 2.84 | 5.55 | -0.13 | 0.3597 | 0.4497 |
| Lab11-2 | 2.72 | 2.86 | 5.58 | -0.14 | 1.4389 | 0.0000 |
| Lab12-1 | 2.73 | 2.86 | 5.59 | -0.13 | 1.7986 | 0.4497 |
| Lab12-2 | 2.72 | 2.87 | 5.59 | -0.15 | 1.7986 | -0.4497 |
| Lab13-1 | 2.68 | 2.83 | 5.51 | -0.15 | -1.0792 | -0.4497 |
| Lab13-2 | 2.68 | 2.84 | 5.52 | -0.16 | -0.7195 | -0.8993 |
| Lab14-1 | 2.7 | 2.84 | 5.54 | -0.14 | 0.0000 | 0.0000 |
| Lab14-2 | 2.7 | 2.84 | 5.54 | -0.14 | 0.0000 | 0.0000 |

| | | | | |
|-----------------------|-------|-------|-------|---------|
| No. of Results | 28 | 28 | 28 | 28 |
| Median | 2.70 | 2.84 | 5.54 | -0.14 |
| Q 1 | 2.70 | 2.83 | 5.53 | -0.15 |
| Q 3 | 2.72 | 2.85 | 5.57 | -0.12 |
| Inter Q Range | 0.02 | 0.02 | 0.04 | 0.03 |
| Normalzd IQR | 0.015 | 0.019 | 0.028 | 0.022 |
| Robust CV,% | 0.549 | 0.653 | 0.502 | -15.885 |
| Minimum | 2.670 | 2.780 | 5.470 | -0.160 |
| Maximum | 2.800 | 2.940 | 5.740 | -0.090 |
| Range | 0.130 | 0.160 | 0.270 | 0.070 |

Table 5: Relative Density (SSD)

| Lab# | S1 S2 | S3 S4 | Between Labs S1+S3 S2+S4 | Within Labs S1-S3 S2-S4 | Between Labs z-score | Within Labs z-score |
|---------|----------|----------|-----------------------------------|----------------------------------|----------------------------|---------------------------|
| Lab1-1 | 2.75 | 2.84 | 5.59 | -0.090 | -0.6348 | 3.3725 |
| Lab1-2 | 2.76 | 2.87 | 5.63 | -0.110 | 0.6348 | 2.0235 |
| Lab2-1 | 2.72 | 2.82 | 5.54 | -0.100 | -2.2219 | 2.6980 |
| Lab2-2 | 2.7 | 2.84 | 5.54 | -0.140 | -2.2219 | 0.0000 |
| Lab3-1 | 2.73 | 2.88 | 5.61 | -0.150 | 0.0000 | -0.6745 |
| Lab3-2 | 2.74 | 2.88 | 5.62 | -0.140 | 0.3174 | 0.0000 |
| Lab4-1 | 2.73 | 2.88 | 5.61 | -0.150 | 0.0000 | -0.6745 |
| Lab4-2 | 2.74 | 2.88 | 5.62 | -0.140 | 0.3174 | 0.0000 |
| Lab5-1 | 2.73 | 2.86 | 5.59 | -0.130 | -0.6348 | 0.6745 |
| Lab5-2 | 2.73 | 2.86 | 5.59 | -0.130 | -0.6348 | 0.6745 |
| Lab6-1 | 2.73 | 2.86 | 5.59 | -0.130 | -0.6348 | 0.6745 |
| Lab6-2 | 2.74 | 2.88 | 5.62 | -0.140 | 0.3174 | 0.0000 |
| Lab7-1 | 2.73 | 2.86 | 5.59 | -0.130 | -0.6348 | 0.6745 |
| Lab7-2 | 2.74 | 2.87 | 5.61 | -0.130 | 0.0000 | 0.6745 |
| Lab8-1 | 2.77 | 2.91 | 5.68 | -0.140 | 2.2219 | 0.0000 |
| Lab8-2 | 2.76 | 2.91 | 5.67 | -0.150 | 1.9044 | -0.6745 |
| Lab9-1 | 2.84 | 2.98 | 5.82 | -0.140 | 6.6656 | 0.0000 |
| Lab9-2 | 2.82 | 2.98 | 5.8 | -0.160 | 6.0307 | -1.3490 |
| Lab10-1 | 2.73 | 2.88 | 5.61 | -0.150 | 0.0000 | -0.6745 |
| Lab10-2 | 2.74 | 2.87 | 5.61 | -0.130 | 0.0000 | 0.6745 |
| Lab11-1 | 2.74 | 2.88 | 5.62 | -0.140 | 0.3174 | 0.0000 |
| Lab11-2 | 2.74 | 2.90 | 5.64 | -0.160 | 0.9522 | -1.3490 |
| Lab12-1 | 2.76 | 2.88 | 5.64 | -0.120 | 0.9522 | 1.3490 |
| Lab12-2 | 2.75 | 2.89 | 5.64 | -0.140 | 0.9522 | 0.0000 |
| Lab13-1 | 2.72 | 2.87 | 5.59 | -0.150 | -0.6348 | -0.6745 |
| Lab13-2 | 2.72 | 2.87 | 5.59 | -0.150 | -0.6348 | -0.6745 |
| Lab14-1 | 2.73 | 2.88 | 5.61 | -0.150 | 0.0000 | -0.6745 |
| Lab14-2 | 2.73 | 2.88 | 5.61 | -0.150 | 0.0000 | -0.6745 |

| | | | | |
|----------------|-------|-------|-------|--------|
| No. of Results | 28 | 28 | 28 | 28 |
| Median | 2.740 | 2.880 | 5.610 | -0.140 |
| Q 1 | 2.73 | 2.87 | 5.59 | -0.15 |
| Q 3 | 2.75 | 2.88 | 5.63 | -0.13 |
| Inter Q Range | 0.020 | 0.012 | 0.043 | 0.020 |
| Normalzd IQR | 0.015 | 0.009 | 0.032 | 0.015 |
| Robust CV,% | 0.54 | 0.32 | 0.56 | -10.59 |
| Minimum | 2.70 | 2.82 | 5.54 | -0.16 |
| Maximum | 2.84 | 2.98 | 5.82 | -0.09 |
| Range | 0.14 | 0.16 | 0.28 | 0.07 |

Table 6: Apparent Relative Density

| Lab# | S1 S2 | S3 S4 | Between Labs S1+S3 S2+S4 | Within Labs S1-S3 S2-S4 | Between Labs z-score | Within Labs z-score |
|---------|----------|----------|-----------------------------------|----------------------------------|----------------------------|---------------------------|
| Lab1-1 | 2.81 | 2.92 | 5.73 | -0.110 | 0.0000 | 5.3959 |
| Lab1-2 | 2.82 | 2.94 | 5.76 | -0.120 | 2.0235 | 4.0469 |
| Lab2-1 | 2.78 | 2.92 | 5.7 | -0.140 | -2.0235 | 1.3490 |
| Lab2-2 | 2.78 | 2.93 | 5.71 | -0.150 | -1.3490 | 0.0000 |
| Lab3-1 | 2.79 | 2.94 | 5.73 | -0.150 | 0.0000 | 0.0000 |
| Lab3-2 | 2.79 | 2.93 | 5.72 | -0.140 | -0.6745 | 1.3490 |
| Lab4-1 | 2.79 | 2.96 | 5.75 | -0.170 | 1.3490 | -2.6980 |
| Lab4-2 | 2.8 | 2.95 | 5.75 | -0.150 | 1.3490 | 0.0000 |
| Lab5-1 | 2.79 | 2.94 | 5.73 | -0.150 | 0.0000 | 0.0000 |
| Lab5-2 | 2.79 | 2.94 | 5.73 | -0.150 | 0.0000 | 0.0000 |
| Lab6-1 | 2.79 | 2.92 | 5.71 | -0.130 | -1.3490 | 2.6980 |
| Lab6-2 | 2.8 | 2.95 | 5.75 | -0.150 | 1.3490 | 0.0000 |
| Lab7-1 | 2.78 | 2.93 | 5.71 | -0.150 | -1.3490 | 0.0000 |
| Lab7-2 | 2.79 | 2.94 | 5.73 | -0.150 | 0.0000 | 0.0000 |
| Lab8-1 | 2.81 | 2.95 | 5.76 | -0.140 | 2.0235 | 1.3490 |
| Lab8-2 | 2.8 | 2.94 | 5.74 | -0.140 | 0.6745 | 1.3490 |
| Lab9-1 | 2.9 | 3.06 | 5.96 | -0.160 | 15.5133 | -1.3490 |
| Lab9-2 | 2.89 | 3.06 | 5.95 | -0.170 | 14.8388 | -2.6980 |
| Lab10-1 | 2.79 | 2.94 | 5.73 | -0.150 | 0.0000 | 0.0000 |
| Lab10-2 | 2.8 | 2.95 | 5.75 | -0.150 | 1.3490 | 0.0000 |
| Lab11-1 | 2.79 | 2.93 | 5.72 | -0.140 | -0.6745 | 1.3490 |
| Lab11-2 | 2.8 | 2.94 | 5.74 | -0.140 | 0.6745 | 1.3490 |
| Lab12-1 | 2.8 | 2.93 | 5.73 | -0.130 | 0.0000 | 2.6980 |
| Lab12-2 | 2.8 | 2.93 | 5.73 | -0.130 | 0.0000 | 2.6980 |
| Lab13-1 | 2.79 | 2.94 | 5.73 | -0.150 | 0.0000 | 0.0000 |
| Lab13-2 | 2.79 | 2.94 | 5.73 | -0.150 | 0.0000 | 0.0000 |
| Lab14-1 | 2.79 | 2.95 | 5.74 | -0.160 | 0.6745 | -1.3490 |
| Lab14-2 | 2.79 | 2.95 | 5.74 | -0.160 | 0.6745 | -1.3490 |

| | | | | |
|----------------|-------|-------|-------|-------|
| No. of Results | 28 | 28 | 28 | 28 |
| Median | 2.79 | 2.94 | 5.73 | -0.15 |
| Q 1 | 2.79 | 2.93 | 5.73 | -0.15 |
| Q 3 | 2.80 | 2.95 | 5.75 | -0.14 |
| Inter Q Range | 0.010 | 0.020 | 0.020 | 0.010 |
| Normalzd IQR | 0.007 | 0.015 | 0.015 | 0.007 |
| Robust CV,% | 0.27 | 0.50 | 0.26 | -4.94 |
| Minimum | 2.78 | 2.92 | 5.7 | -0.17 |
| Maximum | 2.90 | 3.06 | 5.96 | -0.11 |
| Range | 0.12 | 0.14 | 0.26 | 0.06 |

Table 7: Water absorption

| Lab# | S1 S2 | S3 S4 | Between Labs S1+S3 S2+S4 | Within Labs S1-S3 S2-S4 | Between Labs z-score | Within Labs z-score |
|---------|----------|----------|-----------------------------------|----------------------------------|----------------------------|---------------------------|
| Lab1-1 | 1.10 | 1.40 | 2.50 | -0.30 | 0.000 | -0.830 |
| Lab1-2 | 1.10 | 1.30 | 2.40 | -0.20 | -0.450 | -0.415 |
| Lab2-1 | 1.30 | 1.70 | 3.00 | -0.40 | 2.248 | -1.245 |
| Lab2-2 | 1.40 | 1.60 | 3.00 | -0.20 | 2.248 | -0.415 |
| Lab3-1 | 1.20 | 1.00 | 2.20 | 0.20 | -1.349 | 1.245 |
| Lab3-2 | 1.20 | 1.00 | 2.20 | 0.20 | -1.349 | 1.245 |
| Lab4-1 | 1.20 | 1.30 | 2.50 | -0.10 | 0.000 | 0.000 |
| Lab4-2 | 1.20 | 1.30 | 2.50 | -0.10 | 0.000 | 0.000 |
| Lab5-1 | 1.20 | 1.50 | 2.70 | -0.30 | 0.899 | -0.830 |
| Lab5-2 | 1.20 | 1.50 | 2.70 | -0.30 | 0.899 | -0.830 |
| Lab6-1 | 1.20 | 1.10 | 2.30 | 0.10 | -0.899 | 0.830 |
| Lab6-2 | 1.20 | 1.30 | 2.50 | -0.10 | 0.000 | 0.000 |
| Lab7-1 | 1.00 | 1.30 | 2.30 | -0.30 | -0.899 | -0.830 |
| Lab7-2 | 1.00 | 1.30 | 2.30 | -0.30 | -0.899 | -0.830 |
| Lab8-1 | 0.80 | 0.60 | 1.40 | 0.20 | -4.946 | 1.245 |
| Lab8-2 | 0.80 | 0.60 | 1.40 | 0.20 | -4.946 | 1.245 |
| Lab9-1 | 1.20 | 1.30 | 2.50 | -0.10 | 0.000 | 0.000 |
| Lab9-2 | 1.20 | 1.30 | 2.50 | -0.10 | 0.000 | 0.000 |
| Lab10-1 | 1.20 | 1.30 | 2.50 | -0.10 | 0.000 | 0.000 |
| Lab10-2 | 1.20 | 1.40 | 2.60 | -0.20 | 0.450 | -0.415 |
| Lab11-1 | 1.20 | 1.10 | 2.30 | 0.10 | -0.899 | 0.830 |
| Lab11-2 | 1.20 | 1.10 | 2.30 | 0.10 | -0.899 | 0.830 |
| Lab12-1 | 0.90 | 0.80 | 1.70 | 0.10 | -3.597 | 0.830 |
| Lab12-2 | 1.00 | 0.70 | 1.70 | 0.30 | -3.597 | 1.660 |
| Lab13-1 | 1.5 | 1.3 | 2.80 | 0.20 | 1.349 | 1.245 |
| Lab13-2 | 1.5 | 1.3 | 2.80 | 0.20 | 1.349 | 1.245 |
| Lab14-1 | 1.2 | 1.4 | 2.60 | -0.20 | 0.450 | -0.415 |
| Lab14-2 | 1.2 | 1.4 | 2.60 | -0.20 | 0.450 | -0.415 |

| | | | | |
|----------------|--------|--------|--------|---------|
| No. of Results | 28 | 28 | 28 | 28 |
| Median | 1.20 | 1.30 | 2.50 | -0.10 |
| Q 1 | 1.10 | 1.10 | 2.30 | -0.20 |
| Q 3 | 1.20 | 1.40 | 2.60 | 0.13 |
| Inter Q Range | 0.10 | 0.30 | 0.30 | 0.33 |
| Normalzd IQR | 0.0741 | 0.2224 | 0.2224 | 0.2409 |
| Robust CV,% | 6.18 | 17.11 | 8.90 | -240.92 |
| Minimum | 0.80 | 0.60 | 1.40 | -0.40 |
| Maximum | 1.50 | 1.70 | 3.00 | 0.30 |
| Range | 0.70 | 1.10 | 1.60 | 0.70 |













