BRNO UNIVERSITY OF TECHNOLOGY

FACULTY OF CIVIL ENGINEERING
institute of building testing

Z 7008

FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program
Masonry Units Testing
ZZP 2025/1

Brno University of Technology
Proficiency testing provider at the SZK FAST
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Czech Republic

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1 Introduction and Important Contacts

In the year 2024, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZZP 2025/1 whose aim was to verify and assess the conformity of test results across laboratories when testing masonry units.

The assessment of the results of the Proficiency Testing Program was carried out by a committee consisting of the following PT Provider employees:

Head of the PT Provider, PTP coordinator

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The subjects of proficiency testing were the following testing procedures:

1. **EN 772-1** – Compressive strength [1].
2. **EN 772-3** – Net volume and percentage of voids of clay masonry units by hydrostatic weighing [2].
3. **EN 772-6** – Bending tensile strength of aggregate concrete masonry units [3].
4. **EN 772-7** – Water absorption of clay masonry damp proof course units by boiling in water [4].
5. **EN 772-10** – Moisture content [5].
6. **EN 772-11** – Water absorption [6].
7. **EN 772-13** – Dry density of masonry units [7].
8. **EN 15435** – part 4.9.3, Appendix B - Flexural strength of side shutters [8].
9. **EN 15435** – part 5.2 - Density [8].

Testing procedures No **2 – 9** were not open due to low number of participants.

The specimens were taken from the same production with the same production date. The test results from individual PTP participants were compared via a method involving the statistical analysis of all their results in a manner complying with ISO 5725-2 [9] and with EN ISO/IEC 17043 [10]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

4 laboratories from Europe took part in the program. In order to maintain the anonymity of the PTP, each laboratory was given an identification number that will be used henceforth in this document. An integral part of the present final report is a Certificate of Participation in the Proficiency Testing Program. It is unique for each participant and includes the participant's ID used in this report. The following chart shows the participation of laboratories in individual parts of the PTP.

Table 1: Participation of individual laboratories in the PTP (tests designated according to part 1)

ID/Method	1
47337a	X
529ce0	X
8e9c17	X
86cc40	X

Table 2: List of participants (laboratories) – the order in the table does not correspond to the identification number in Table 1

Laboratory	Address	Accreditation number
Institut technologie a testování betonu, s.r.o., Zkušební laboratoř ITTB Brno	Medkova 974/4„ Brno - Tuřany, 62700, Česká republika	L1778
Kloknerův ústav, ČVUT v Praze	Šolínova 1903/7, Praha 6, 166 08, Česká republika	1061
LABKONSULT PLUIS OOD	Airport Sofia, North Area, str. ”8-th”, Sofia, 1540, Bulgaria	-
LEPL Levan Samkharauli National Forensics Bureau	84 Chavchavadze Avenue, Tbilisi, 0162, Georgia	GAC-TL-0166

2 Procedures used in the Statistical Analysis of Laboratory Results

The statistical analysis is based on the following steps:

1. Evaluation of intralaboratory variabilities by Cochran's C test: If 5% or 1% critical value is exceeded, the effect of the individual observations is first considered. If the results indicate that high participant variability is caused by a single observation, this value is excluded from the experiment, but the participant is not excluded as outlying. By overcoming 1% of the critical value, the participant's results can be marked as outlying and excluded from the experiment.
2. The numerical critical evaluation of the test results using Grubbs' test: By overcoming 1% critical value, the participant's results can be marked as outlying and excluded from the experiment.
3. Graphical determination of the consistency of laboratories (Mandel's statistics): The exceedance of the critical values of Mandel's statistics does not indicate that the results of the laboratories concerned are wrong; it only suggests minor inconsistencies.
4. Evaluation of descriptive statistics and, if possible, taking into account the number of observations, the repeatability and reproducibility.
5. Evaluation of the assigned value.
6. The performance evaluation: The most significant outcome of the PT Program is the so-called z-score and ζ-score (zeta-score).These characteristics assess the performance of individual participants by comparing it with the assigned value and measurement uncertainties. z-score and ζ-score are compared with limit values. The resulting ζ-score values are not taken into account during the final evaluation of the performance of participants as they are to a considerable degree dependent on the values of the measurement uncertainties of the assessed institutions.

Procedures used in the statistical analysis of proficiency testing programs can be found here: http://ptprovider.cz/?lang=en.

3 Conclusions of the Statistical Analysis

The present report summarizes the results of the Proficiency Testing Program Masonry Units Testing (PT Program) organized by the PT Provider at the SZK FAST. 4 participants (laboratories) took part in the PT Program. The program focused on ordinary standardized testing of masonry units. The test results are evaluated separately for each testing procedure examined. An evaluation of statistical characteristics is included in the Appendix, as well as test results and graphic presentations. Testing methods can be found in part 1 of this report.

Table 4: Evaluation of overall performance and outliers.
✓ – satisfactory performance; ? – questionable performance; ! – unsatisfactory performance; X – outlier;

ID / Method	1
47337a	✓
529ce0	✓
86cc40	✓
8e9c17	✓

References

[1] EN 772-1+A1. *Methods of test for masonry units - Part 1: Determination of compressive strength*. 2015.

[2] EN 772-3. *Methods of test for masonry units - Part 3: Determination of net volume and percentage of voids of clay masonry units by hydrostatic weighing*. 1999.

[3] EN 772-6. *Methods of test for masonry units - Part 6: Determination of bending tensile strength of aggregate concrete masonry units*. 2002.

[4] EN 772-7. *Methods of test for masonry units - Part 7: Determination of water absorption of clay masonry damp proof course units by boiling in water*. 1999.

[5] EN 772-10. *Methods of test for masonry units - Part 10: Determination of moisture content of calcium silicate and autoclaved aerated concrete units*. 1999.

[6] EN 772-11. *Methods of test for masonry units - Part 11: Determination of water absorption of aggregate concrete, manufactured stone and natural stone masonry units due to capillary action and the initial rate of water absorption of clay masonry units*. 2011.

[7] EN 772-13. *Methods of test for masonry units - Part 13: Determination of net and gross dry density of masonry units (except for natural stone)*. 2001.

[8] EN 15435. *Precast concrete products - Normal weight and lightweight concrete shuttering blocks - Product properties and performance*. 2009.

[9] ISO 5725-2. *Accuracy (trueness and precision) of measurement methods and results - Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*. 2019.

[10] EN ISO/IEC 17043. *Conformity assessment - General requirements for proficiency testing*. 2010.

1 Appendix – EN 772-1 (Compressive strength)

1.1 Test results

Table 4: Test results - ordered by average value. Outliers are marked by red color. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID	Test results [N/mm²]						u_X [N/mm²]	$\bar{x}$ [N/mm²]	s_0 [N/mm²]	V_X [%]
47337a	12.6	12.3	13.2	12.5	12.5	13.4	0.90	12.8	0.44	3.46
86cc40	17.5	20.0	16.0	18.6	16.0	19.8	0.50	18.0	1.78	9.90
529ce0	19.5	22.3	22.7	20.1	18.8	18.9	2.80	20.4	1.71	8.39
8e9c17	29.7	24.3	27.1	24.6	25.9	23.8	3.50	25.9	2.22	8.55

1.2 The Numerical Procedure for Determining Outliers

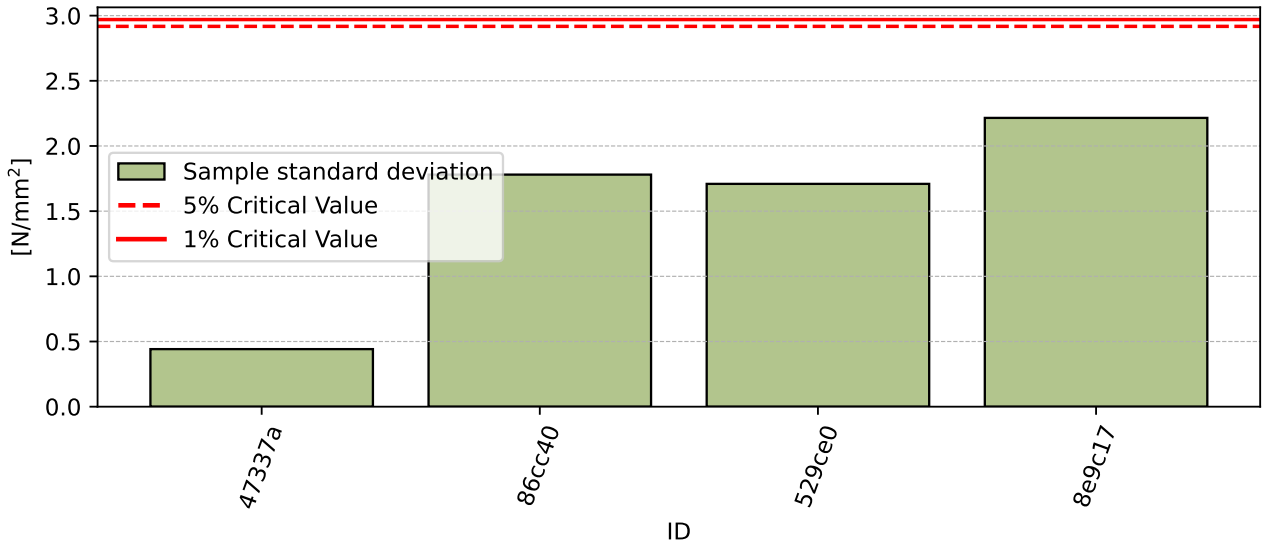

Figure 1: **Cochran's test** - sample standard deviations

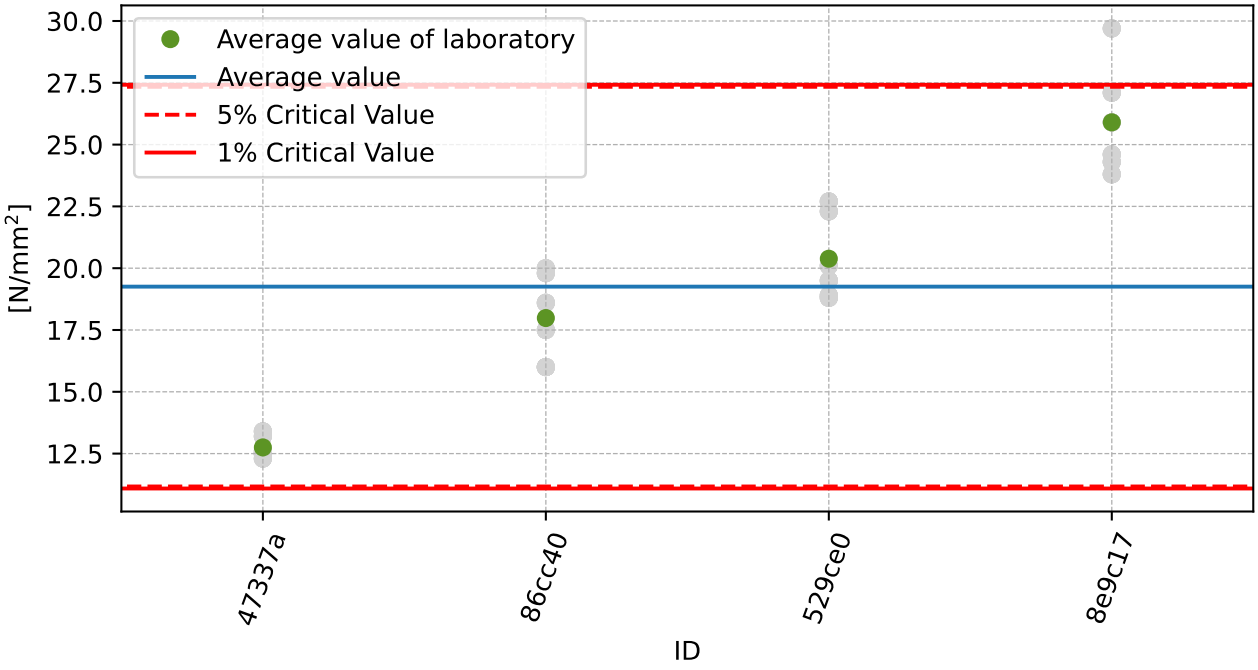

Figure 2: **Grubbs' test** - average values

1.3 Mandel's Statistics

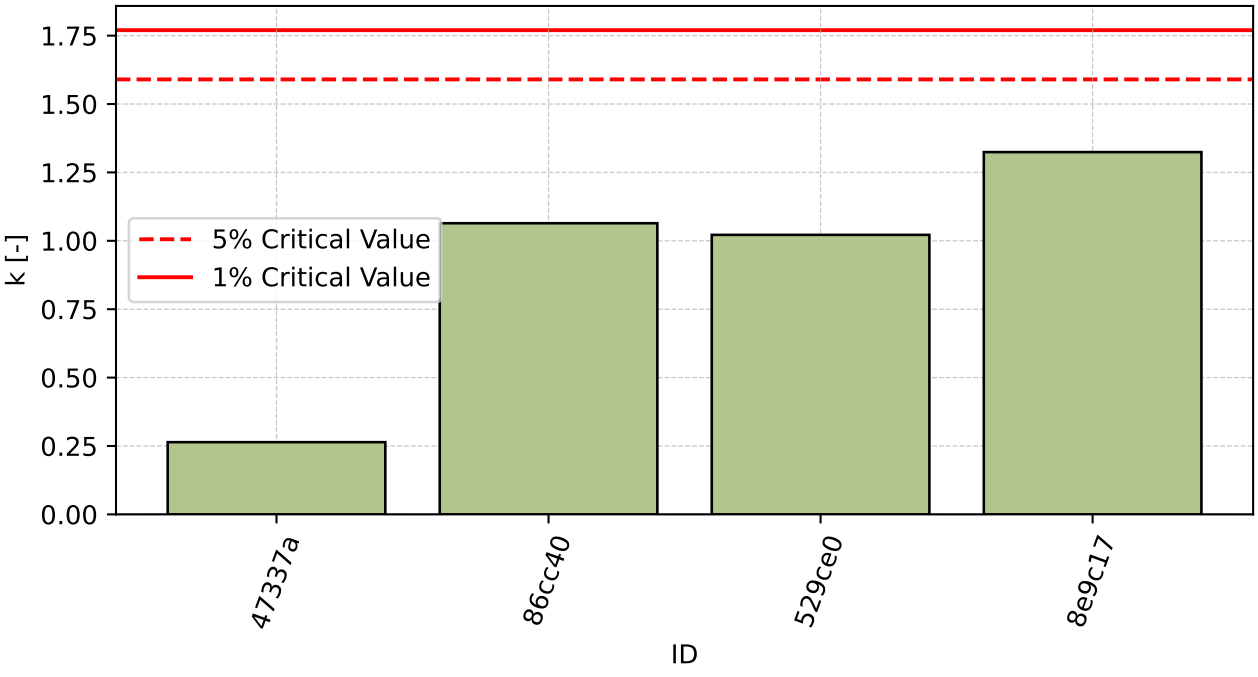

Figure 3: Intralaboratory Consistency Statistic

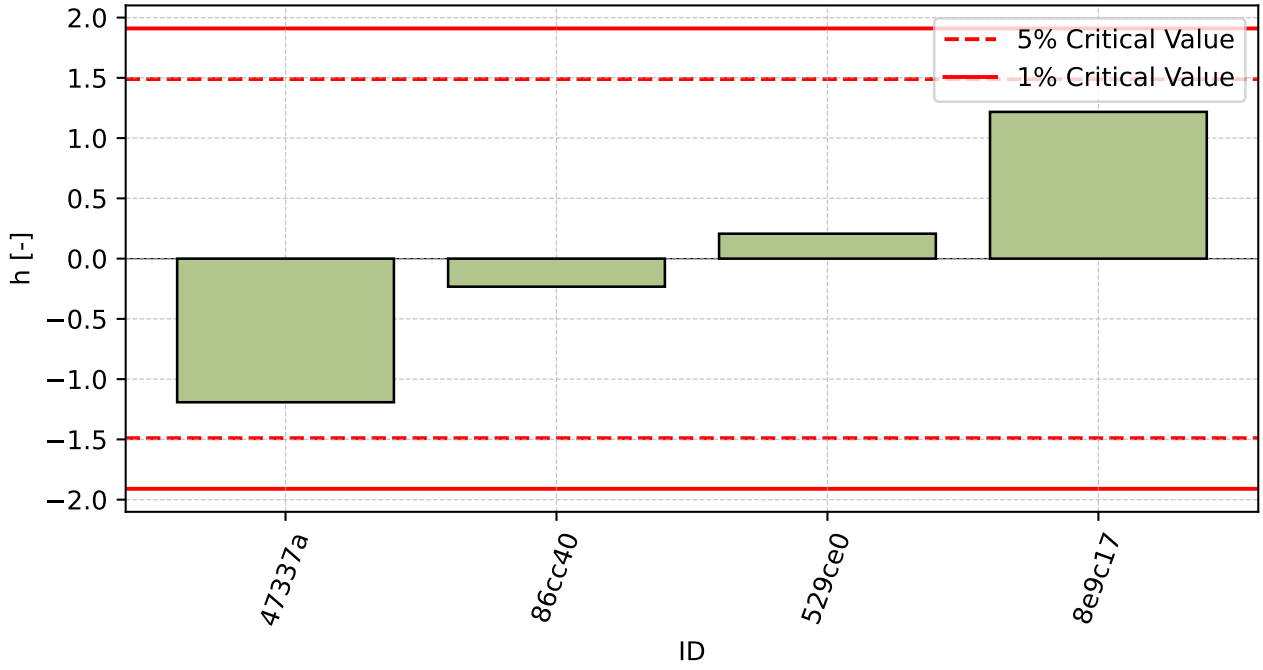

Figure 4: Interlaboratory Consistency Statistic

1.4 Descriptive statistics

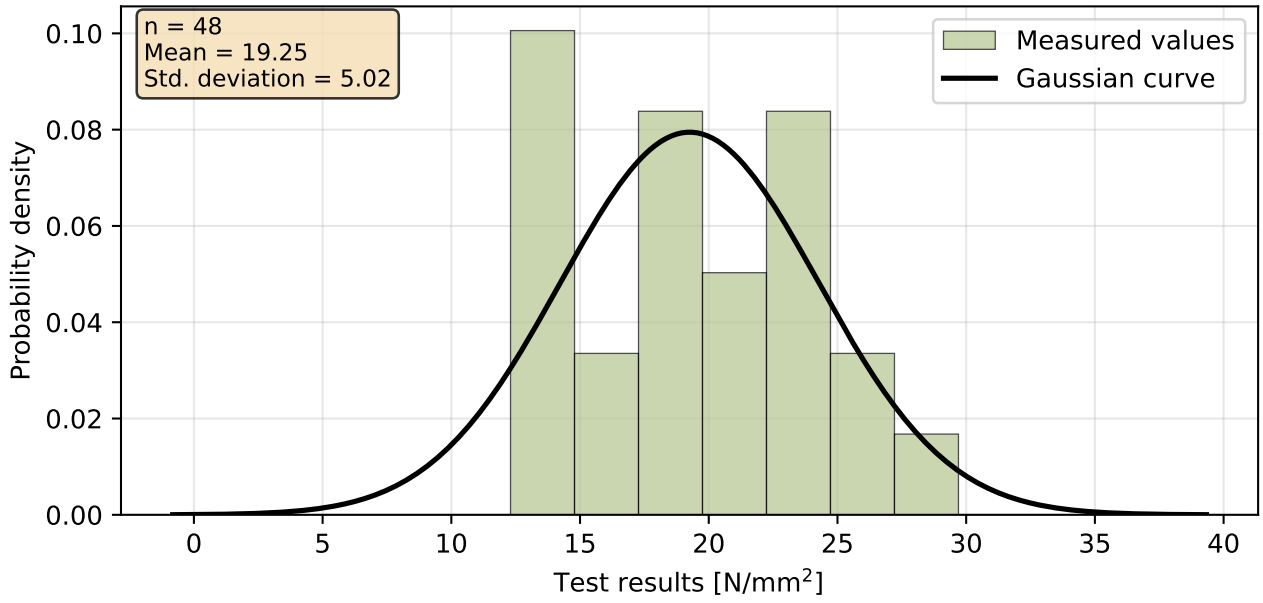

Figure 5: Histogram of all test results

Table 5: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	19.3
Sample standard deviation – s	5.46
Asigned value – x^*	19.3
Robust standard deviation – s^*	5.46
Measurement uncertainty of asigned value – u_X	2.73
p-value of normality test	0.249 [-]
Interlaboratory standard deviation – s_L	5.41
Repeatability standard deviation – s_r	1.67
Reproducibility standard deviation – s_R	5.67
Repeatability – r	4.7
Reproducibility – R	15.9

1.5 Evaluation of Performance Statistics

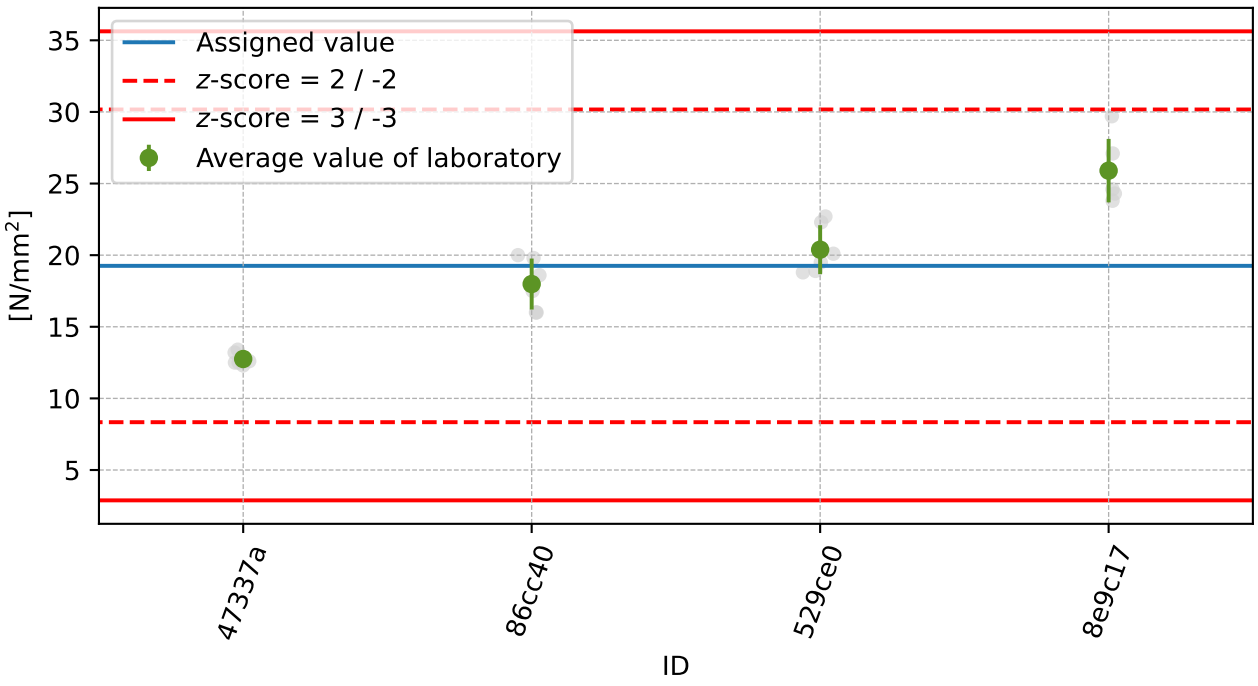

Figure 6: Average values and sample standard deviations

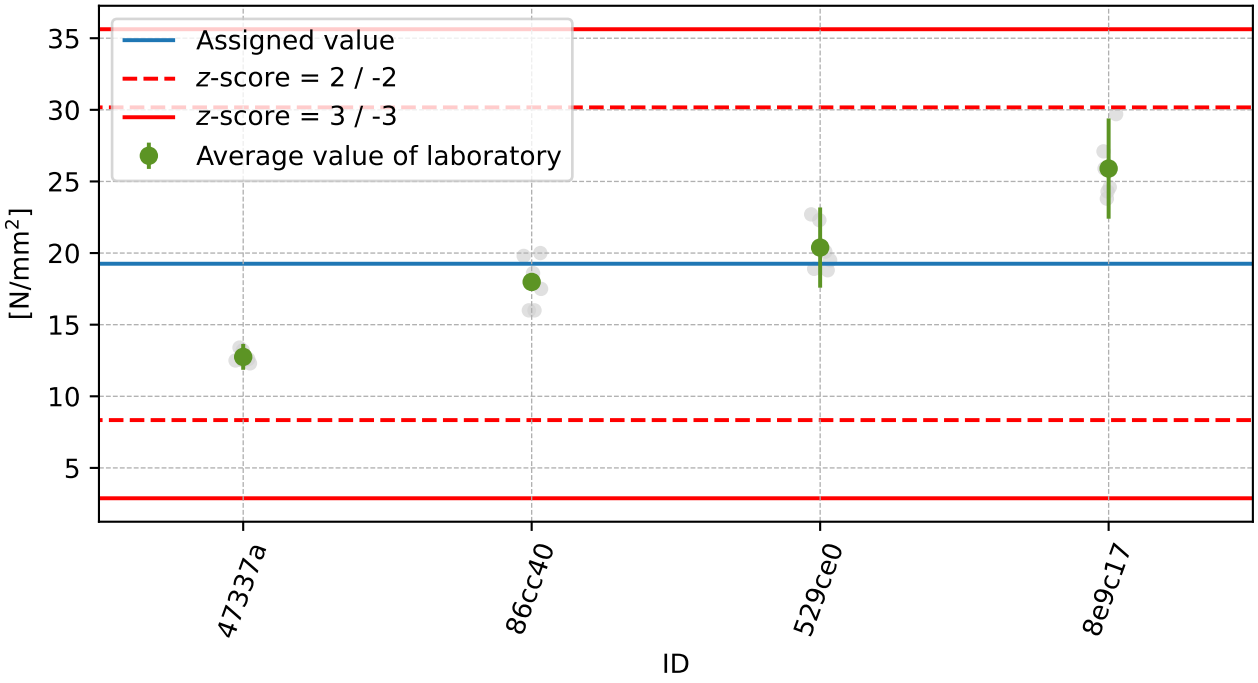

Figure 7: Average values and extended uncertainties of measurement

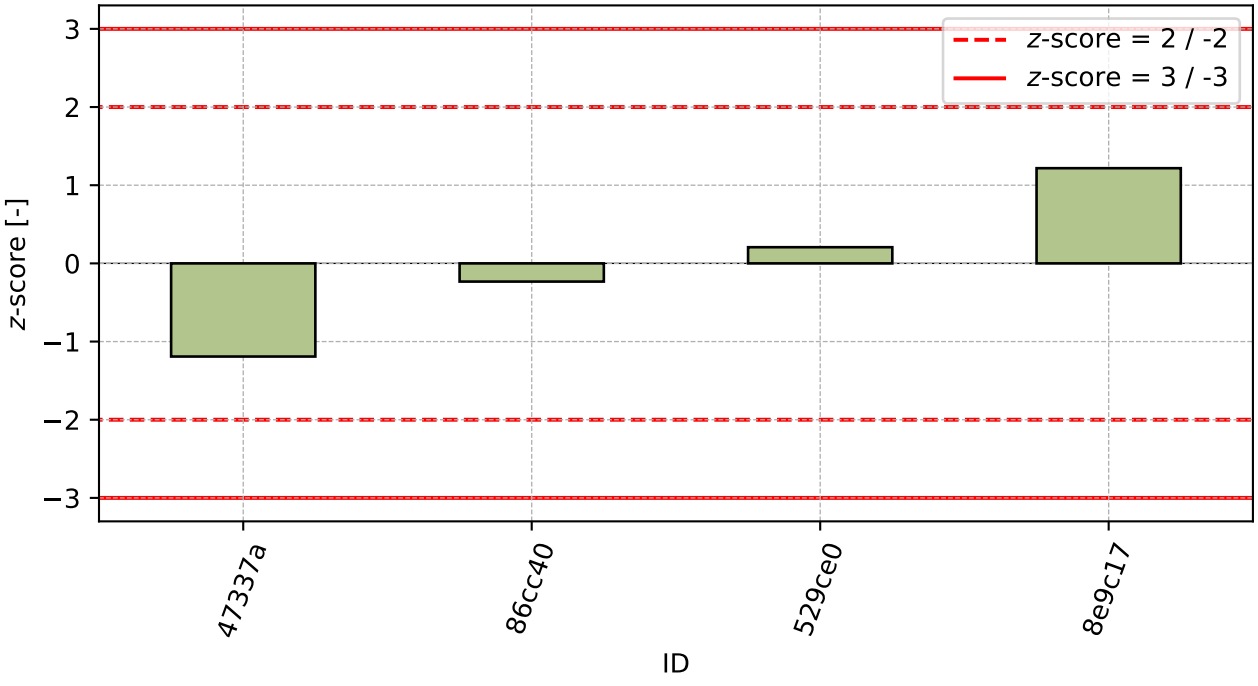

Figure 8: z-score

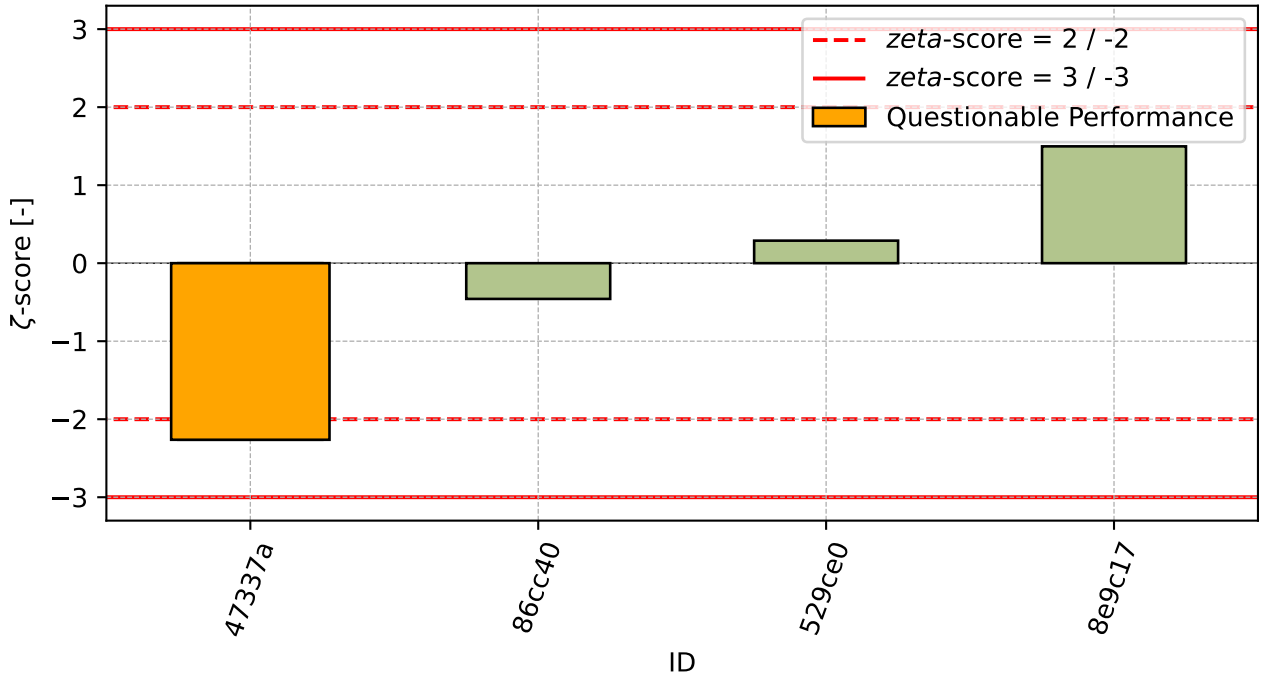

Figure 9: ζ-score

Table 6: *z*-score and ζ-score

ID	*z*-score [-]	ζ-score [-]
47337a	-1.19	-2.26
86cc40	-0.23	-0.46
529ce0	0.21	0.29
8e9c17	1.22	1.5

2 Appendix – EN 772-3 (Net volume and percentage of voids of clay masonry units by hydrostatic weighing)

This part of PT program was not open due to the low number of participants.

3 Appendix – EN 772-6 (Bending tensile strength of aggregate concrete masonry units)

This part of PT program was not open due to the low number of participants.

4 Appendix – EN 772-7 (Water absorption of clay masonry damp proof course units by boiling in water)

This part of PT program was not open due to the low number of participants.

5 Appendix – EN 772-10 (Moisture content)

This part of PT program was not open due to the low number of participants.

6 Appendix – EN 772-11 (Water absorption)

This part of PT program was not open due to the low number of participants.

7 Appendix – EN 772-13 (Dry density of masonry units)

This part of PT program was not open due to the low number of participants.

8 Appendix – EN 15435, part 4.9.3, Appendix B (Flexural strength of side shutters)

This part of PT program was not open due to the low number of participants.

9 Appendix – EN 15435, part 5.2 (Density)

This part of PT program was not open due to the low number of participants.