BRNO UNIVERSITY OF TECHNOLOGY

FACULTY OF CIVIL ENGINEERING
institute of building testing

ilac-MRA

Z 7008

FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program
Mortar, Cement and Fine-grained Cement Composites
ZMC 2024/1

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 ZMC 2024/1 whose aim was to verify and assess the conformity of test results across laboratories when testing mortar, cement and fine-grained cement composites.

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 196-1 – Strength [1]
2. EN 196-2 (art. 4.4.1) – Determination of loss on ignition [2]
3. EN 196-2 (art. 4.4.2) – Determination of sulphate content [2]
4. EN 196-2 (art. 4.4.3) – Determination of the residue insoluble in hydrochloric acid and sodium carbonate [2]
5. EN 196-2 (art. 4.4.4) – Determination of the residue insoluble in hydrochloric acid and potassium hydroxide [2]
6. EN 196-2 (art. 4.4.5) – Determination of sulphite content [2]
7. EN 196-2 (art. 4.4.6) – Determination of manganese content [2]
8. EN 196-3 – Setting time, Soundness[3]
9. EN 196-10 – Determination of the water-soluble chromium (Cr^{6+}) [4]
10. EN 1015-1 – Granularity [5]
11. EN 1015-3 – Consistency [6]
12. EN 1015-6 – Density of fresh mortar [7]
13. EN 1015-10 – Density of hardened mortar [8]
14. EN 1015-11 – Strength [9]
15. EN 1015-12 – Adhesion [10]
16. EN 1015-18 – Capillary absorption coefficient (C_m) [11]
17. EN 1015-19 – Water vapor flow [12]
18. EN 13892-2 – Determination of flexural and compressive strength [13]
19. EN 12004-2 (art. 8.1) – Open time [14]
20. EN 12004-2 (art. 8.2) – Slippage [14]
21. EN 12004-2 (art. 8.3.3.2) – Adhesion [14]

22. EN 12004-2 (art. 8.3.3.3) – Adhesion [14]

Test procedures labeled **2, 4–10, 19, 21, and 22** were not opened due to low participation..

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 [15] and with EN ISO/IEC 17043 [16]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

27 laboratories 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

ID/Part	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
8be574	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-
323f82	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
3f4460	X	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	X	-	-	-	-
974253	X	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-
1a71da	X	-	X	-	-	-	-	-	-	-	X	X	-	-	X	X	X	-	-	X	-	-
cb2337	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-
a12b46	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	-	X	-	-
491268	X	-	-	-	-	-	-	-	-	-	X	-	X	X	X	X	-	-	-	-	-	-
3a1088	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
6d1fa4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
a0e7ed	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ff9dcf	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3e5b0a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
736c97	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	-	X	-	-	-	-	-
59b4fc	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
c876d1	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37d0bb	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	X	-	-
c70061	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
6cd6db	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0d99ca	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05224d	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	X	-	-	-	-	-
972154	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	-	X	-	-
781562	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-
c601d9	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
b5292e	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
240075	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
f38b13	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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

Laboratory	Address	Accreditation number
AXA CERT	Snagov, Tancăbesti, str. Belvedere 20 A, jud. Ilfov, Romania, Snagov, 077167, Romania	-
BEST, a.s.	Lučice 87, Chlumec nad Cidlinou, 50351, Česká republika	1739
BETOTECH, s.r.o.	Beroun 660, Beroun, 26601, Česká republika	1195
Baugrund Institut Knirim OOD	Tsarevo selo 3, atelie parter, Sofia, 1612	255li
CENTER FOR TESTING AND EUROPEAN CERTIFICATION /CTEC/ Ltd.	Industrialna street 2, Stara Zagora, 6000, Stara Zagora	252 ЛИ
Cement Hranice akciová společnost	Bělotínská 288, Hranice I-Město, 753 01, Česko	1284
Geoinvest Ltd	Aglantzias Light Industrial Area, No 10, Nicosia, 2102, Other (Non US)	-
ICS KNAUF GIPS SRL	Stefan cel Mare 178, Balti, 3100, Republic of Moldova	LÎ-026
Itecons	Rua Pedro Hispano, s/n, Pólo II da Universidade de Coimbra„ Coimbra, 3030-289, Portugal	L0446-1
Kiwa GmbH	Voltastraße 5, Berlin, 13355, Germany	-
LABCON LTD	Kentavrou 1, Aradippou Industrial Area, Aradippou, 7101, Larnaca	L066-3
MIRTEC S.A. (EBETAM A.E.)	76 KM OF ATHENS-LAMIA NATIONAL ROAD, RITSONA, 32009, GREECE	-
Magnel-Vandepitte Laboratory	Technologiepark 60, Ghent, 9052, Belgium	220-TEST
SRL CIPC INCERC TEST	Bd. Dacia 38, ap. 336, Chisinau, MD 2060, Moldova	LÎ 125
TESScontrol, s. r. o., Oblastné laboratórium Zvolen, Laboratórium Zvolen,	Hronská 3211/1, 960 93 Zvolen, Zvolen, 960 93, Slovenská republika	S-375
TESScontrol, s.r.o. Oblastné laboratórium Bratislava, Laboratórium Bratislava	Ľubochnianska 1/A, 831 04 Bratislava, Bratislava, 831 04, Slovenská republika	S-375
Technický a zkušební ústav Praha, s.p., Centrální laboratoř, zkušebna 0500 Předměřice nad Labem	Průmyslová 283, Předměřice nad Labem, 503 02, Česká republika	1018.3
Technický a zkušební ústav stavební Praha s.p.	Tolstého 447, Teplice, 415 03, Česká republika	L1018.3
Technický a zkušební ústav stavební Praha, s. p., Centrální laboratoř - zkušebna Brno	Hněvkovského 77, Brno, 617 00, Česká republika	1018.3

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Laboratory	Address	Accreditation number
Technický a zkušební ústav stavební Praha, s.p.	Prosecká 811/76a, Praha 9, 190 00, Česká republika	1018.3
Technický a zkušební ústav stavební Praha, s.p.	U Studia 14, OSTRAVA, 70030, Česko	1018.3
Technický a zkušební ústav stavební Praha, s.p. Pobočka Plzeň	Zahradní 15, Plzeň 2-Slovany, 32600, Česká republika	1018.3
Technický a zkušební ústav stavební Praha, s.p., pobočka České Budějovice	Nemanická 441/8, České Budějovice, 370 04, Česká republika	1018.3
Technický a zkušební ústav stavební Praha, sp - pobočka Plzeň	Zahradní 15, Plzeň3, 326 00, Česká republika	1018.3
UAB Testlita	J. Basanaviciaus str. 160D-2, Šiauliai, LT-76128, Lithuania	-
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Központi Vizsgáló Laboratórium	Dózsa György út 26., Szentendre, 2000, Magyarország	NAH-1-1110/2023/K
Ředitelství silnic a dálnic s. p.	Na Pankráci 546/56, Praha 4, 145 00, Česká republika	1072

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 (symbol **X**).
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 (symbol **X**).
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. The following scales are applied for the z-score values:
   - $|z\text{-score}| < 2 \Rightarrow$ shows that the laboratory performance is **satisfactory** and generates no signal – ✓.
   - $2 \leq |z\text{-score}| < 3 \Rightarrow$ shows that the laboratory performance is **questionable** and generates an action signal – **?**.
   - $|z\text{-score}| \geq 3 \Rightarrow$ shows that the laboratory performance is **unsatisfactory** and generates an action signal – **!**.

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 Mortar, Cement and Fine-grained Cement Composites (PT Program) organized by the PT Provider at the SZK FAST. 27 participants (laboratories) took part in the PT Program. The program focused on ordinary standardized testing of mortar, cement, fine-grained cement composites. 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	3	11	12	13	14	15	16	17	18	20
8be574	?	-	-	-	-	-	-	-	-	✓	✓
323f82	-	✓	-	-	-	✓	-	-	-	-	-
3f4460	✓	-	-	-	✓	?	✓	-	-	✓	-
974253	✓	-	-	✓	✓	✓	-	-	-	-	-
1a71da	✓	X	✓	?	-	-	✓	✓	✓	-	✓
cb2337	-	-	?	-	-	✓	-	-	-	-	-
a12b46	-	-	✓	✓	✓	✓	✓	✓	✓	✓	✓
491268	✓	-	✓	-	✓	✓	✓	✓	-	-	-
3a1088	✓	-	-	-	-	✓	-	-	-	-	-
6d1fa4	-	-	-	-	-	-	-	-	-	✓	-
a0e7ed	-	✓	-	-	-	-	-	-	-	-	-
ff9dcf	!	-	-	-	-	-	-	-	-	-	-
3e5b0a	-	-	-	-	-	-	-	-	-	✓	-
736c97	-	-	✓	✓	-	-	✓	-	✓	-	-
59b4fc	-	-	-	-	-	✓	-	-	-	-	-
c876d1	✓	-	-	-	-	-	-	-	-	-	-
37d0bb	-	✓	-	-	-	-	✓	-	-	-	✓
c70061	-	-	-	-	-	-	-	-	✓	-	-
6cd6db	✓	-	-	-	-	-	-	-	-	-	-
0d99ca	✓	-	-	-	-	-	-	-	-	-	-
05224d	-	-	-	✓	-	-	-	✓	✓	-	-
972154	-	-	✓	✓	✓	✓	✓	✓	✓	✓	✓
781562	-	-	✓	-	-	✓	-	-	-	-	-
c601d9	-	-	-	-	-	✓	-	-	-	-	-
b5292e	-	-	-	-	-	✓	-	-	-	-	-
240075	-	-	-	-	-	✓	-	-	-	-	-
f38b13	✓	-	-	-	-	-	-	-	-	-	-

References

[1] EN 196-1. *Methods of testing cement - Part 1: Determination of strength*. 2016.

[2] EN 196-2. *Method of testing cement - Part 2: Chemical analysis of cement*. 2013.

[3] EN 196-3. *Methods of testing cement - Part 3: Determination of setting times and soundness*. 2017.

[4] EN 196-10. *Methods of testing cement - Part 10: Determination of the water-soluble chromium (VI) content of cement*. 2017.

[5] EN 1015-1. *Methods of test for mortar for masonry - Part 1: Determination of particle size distribution (by sieve analysis)*. 1999.

[6] EN 1015-3. *Methods of test for mortar for masonry - Part 3: Determination of consistence of fresh mortar (by flow table)*. 2000.

[7] EN 1015-6. *Methods of test for mortar for masonry - Part 6: Determination of bulk density of fresh mortar*. 1999.

[8] EN 1015-10. *Methods of test for mortar for masonry - Part 10: Determination of dry bulk density of hardened mortar*. 2000.

[9] EN 1015-11. *Methods of test for mortar for masonry - Part 11: Determination of flexural and compressive strentgth of hardened mortar*. 2000.

[10] EN 1015-12. *Methods of test for mortar for masonry - Part 12: Determination of adhesive strength of hardened rendering and plastering mortars on substrates*. 2000.

[11] EN 1015-18. *Methods of test for mortar for masonry - Part 18: Determination of water absorption coefficient due to capillarity action of hardened mortar*. 2003.

[12] EN 1015-19. *Methods of test for mortar for masonry - Part 19: Determination of water vapour permeability of hardened rendering and plastering mortars*. 1999.

[13] EN 13892-2. *Methods of test for screed materials - Part 2: Determination of flexural and compressive strength*. 2003.

[14] EN 12004-2. *Adhesives for ceramic tiles - Part 2: Test methods*. 2017.

[15] 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.

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

1 Appendix – EN 196-1 – Strength

1.1 Flexural Strength after 2 days of ageing

1.1.1 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/mm^2]			u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
0d99ca	3.0	3.1	3.2	-	3.1	0.1	3.23
6cd6db	3.1	3.2	3.1	-	3.1	0.06	1.84
3f4460	4.4	4.3	4.4	0.2	4.4	0.06	1.32
8be574	4.5	4.7	4.6	0.1	4.6	0.1	2.17
491268	4.7	4.6	4.6	-	4.6	0.06	1.25
974253	5.1	4.5	4.7	0.4	4.8	0.31	6.41
1a71da	5.0	5.0	4.9	-	5.0	0.06	1.16
c876d1	5.6	5.2	5.4	0.5	5.4	0.19	3.45
3a1088	5.7	5.6	5.7	0.3	5.7	0.06	1.02
ff9dcf	13.8	11.5	11.7	1.9	12.3	1.27	10.33

1.1.2 The Numerical Procedure for Determining Outliers

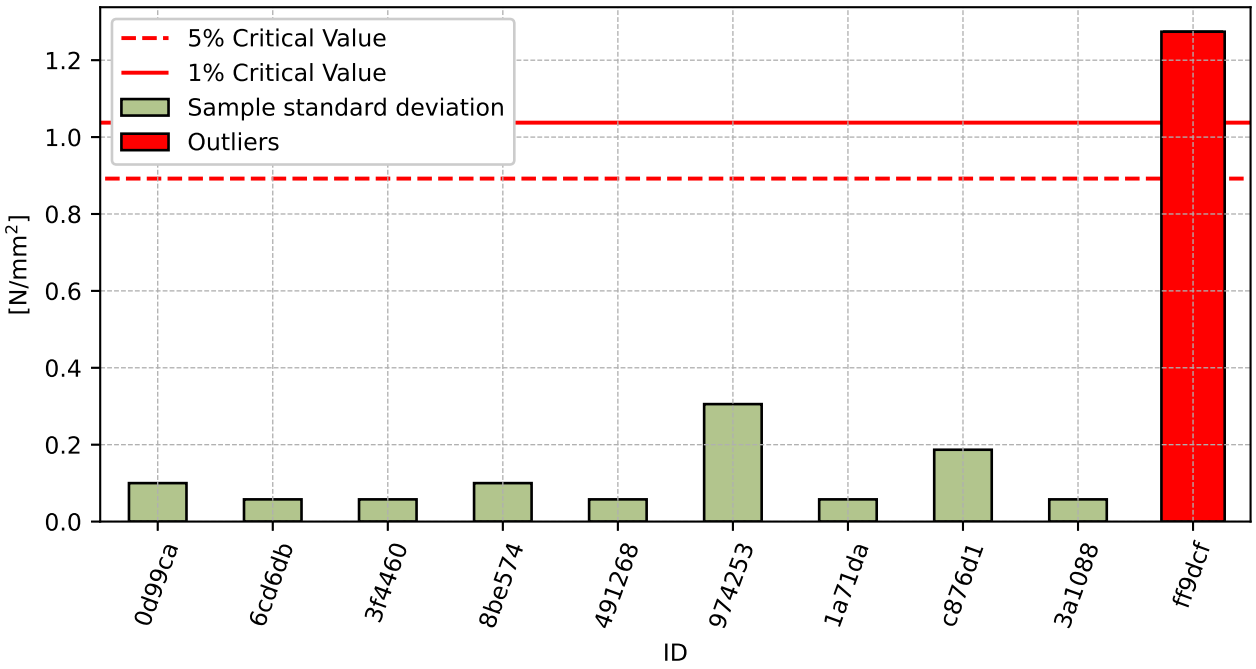

Figure 1: **Cochran's test** - sample standard deviations

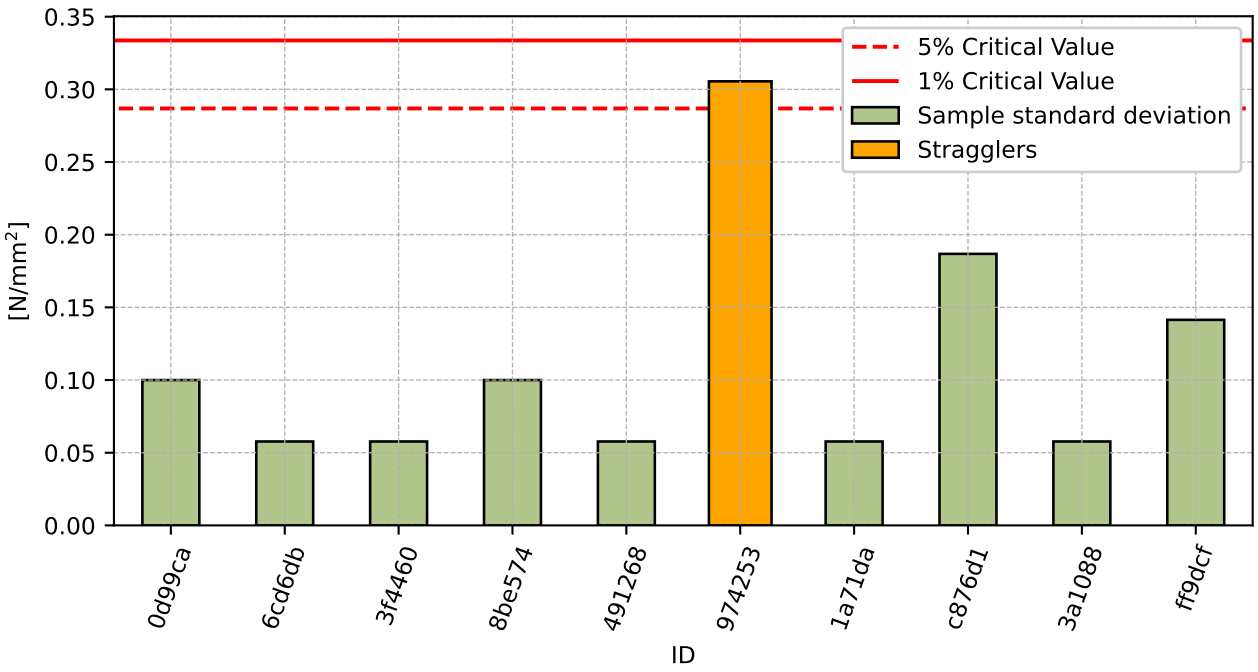

Figure 2: **Cochran's test** - sample standard deviations without outliers

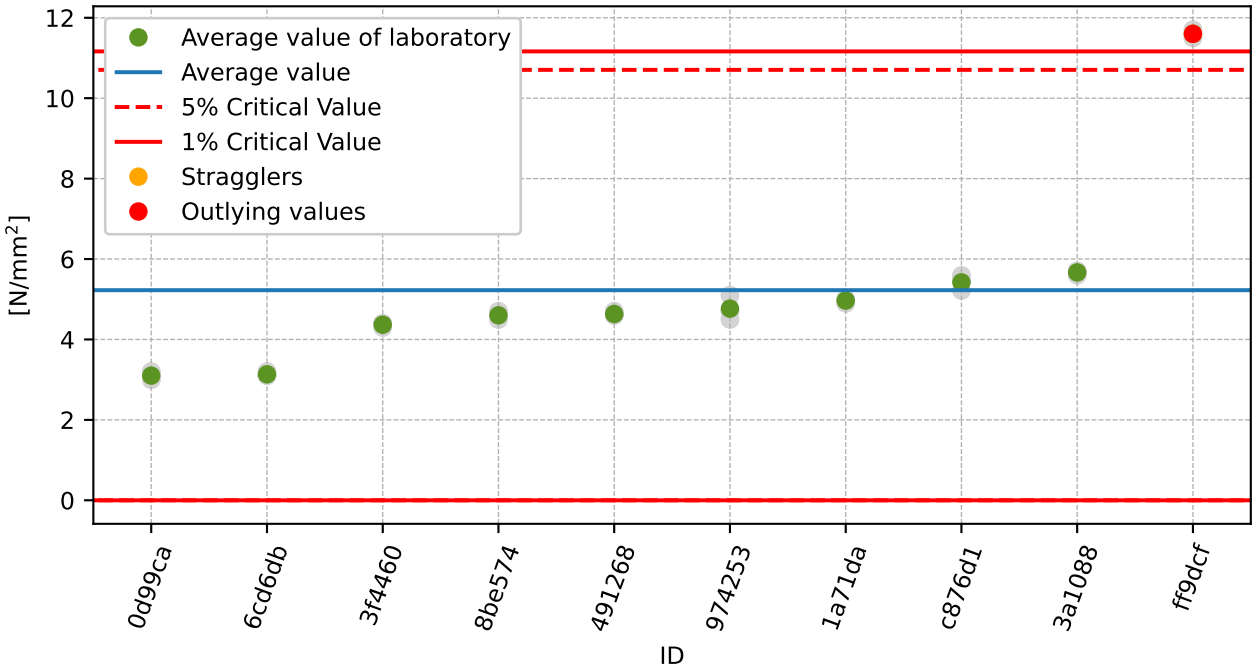

Figure 3: **Grubbs' test** - average values

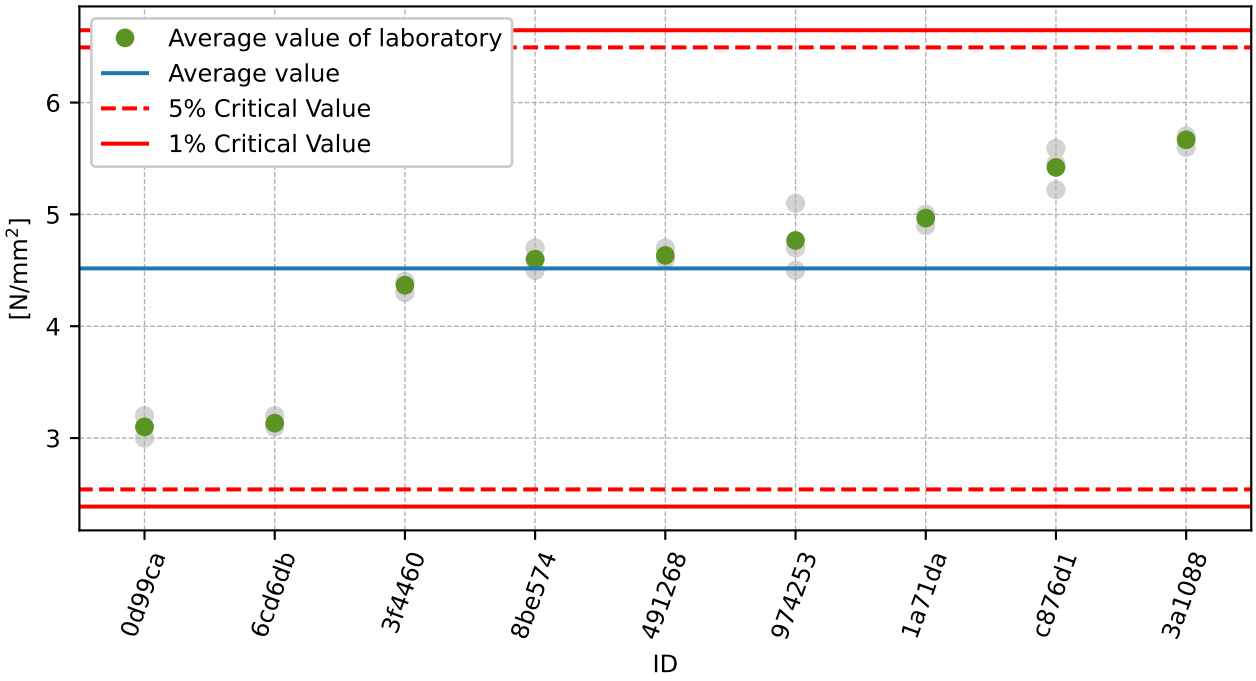

Figure 4: **Grubbs' test** - average values without outliers

1.1.3 Mandel's Statistics

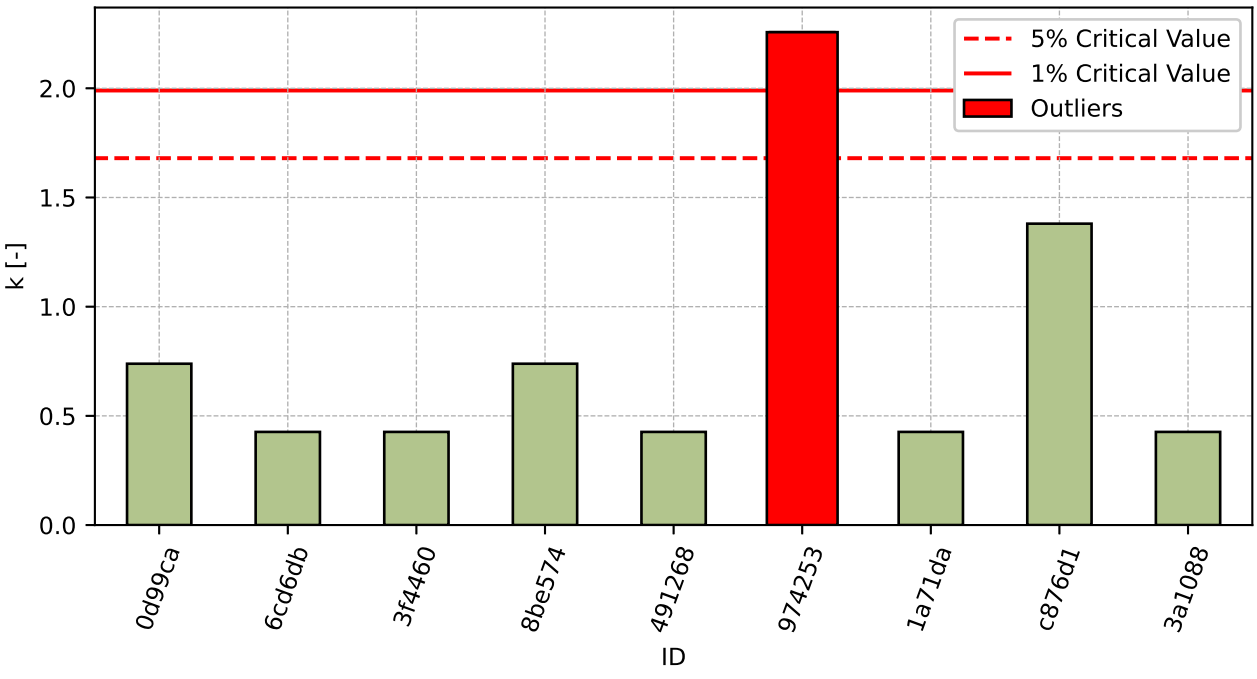

Figure 5: Intralaboratory Consistency Statistic

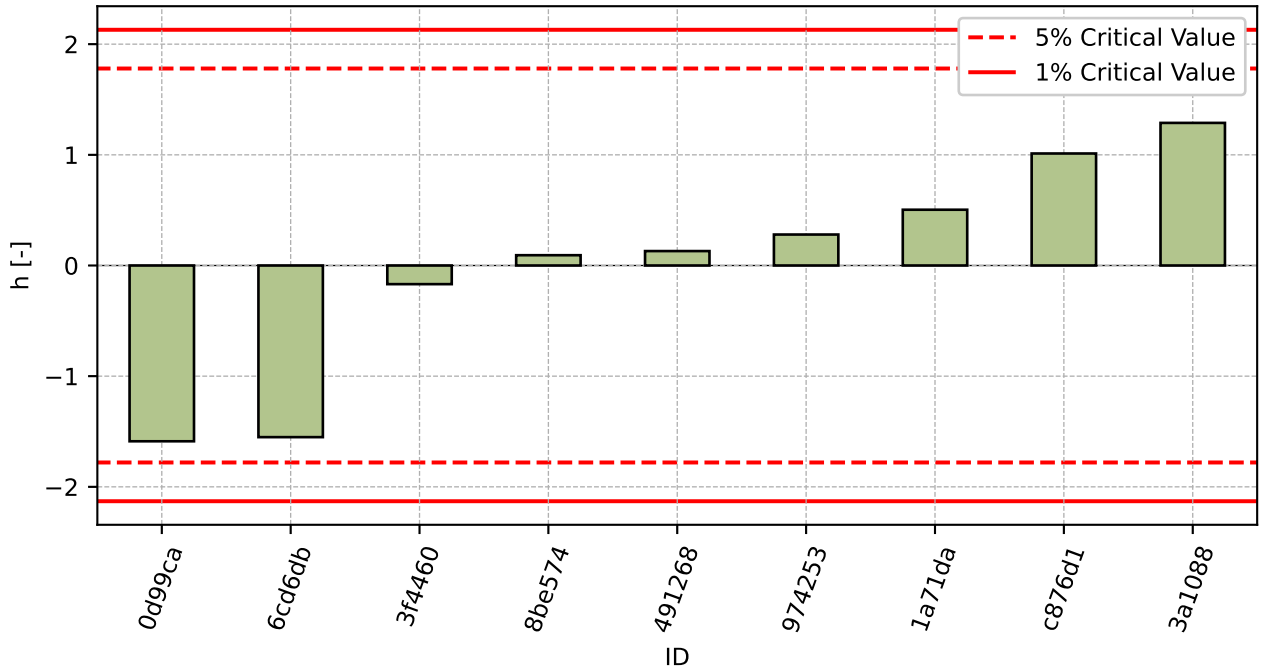

Figure 6: Interlaboratory Consistency Statistic

1.1.4 Descriptive statistics

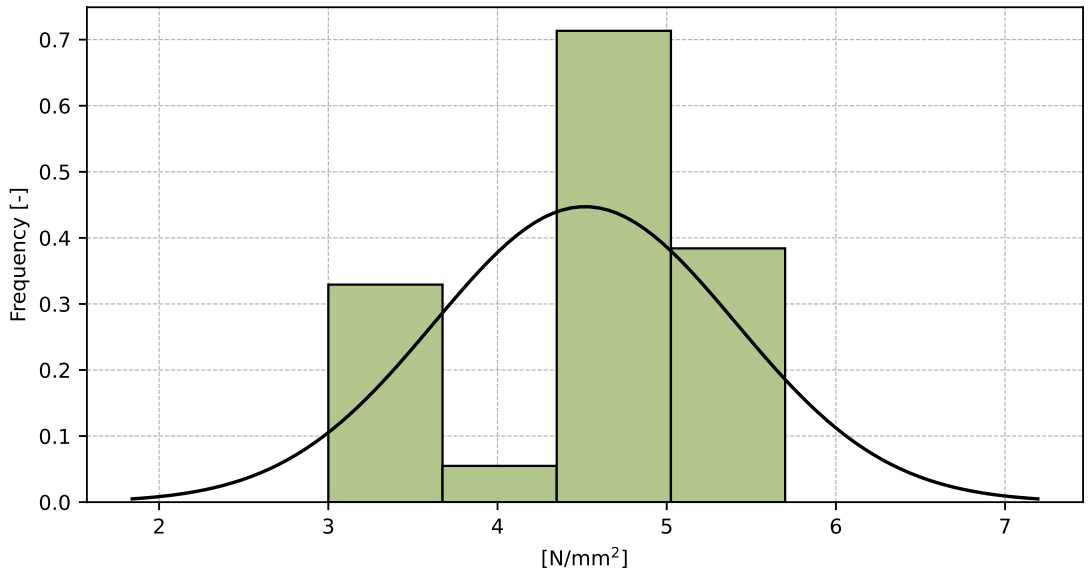

Figure 7: Histogram of all test results

Table 5: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	4.5
Sample standard deviation – s	0.89
Asigned value – x^*	4.7
Robust standard deviation – s^*	0.64
Measurement uncertainty of asigned value – u_X	0.27
p-value of normality test	0.293 [-]
Interlaboratory standard deviation – s_L	0.89
Repeatability standard deviation – s_r	0.14
Reproducibility standard deviation – s_R	0.9
Repeatability – r	0.4
Reproducibility – R	2.5

1.1.5 Evaluation of Performance Statistics

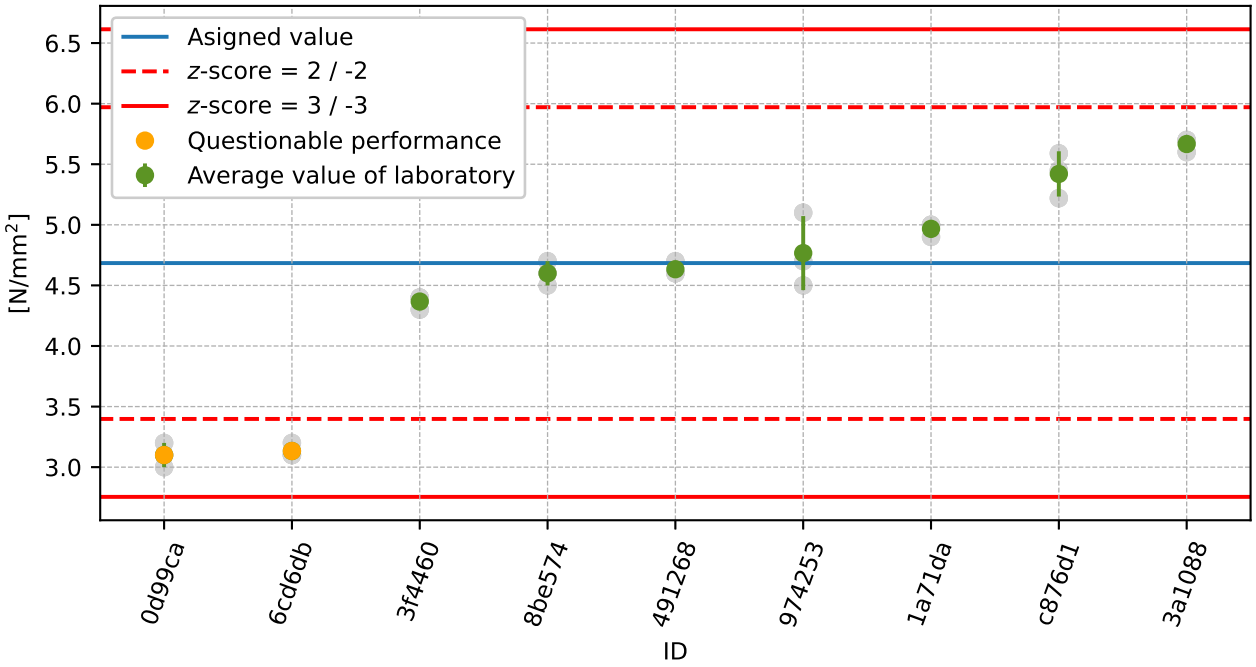

Figure 8: Average values and sample standard deviations

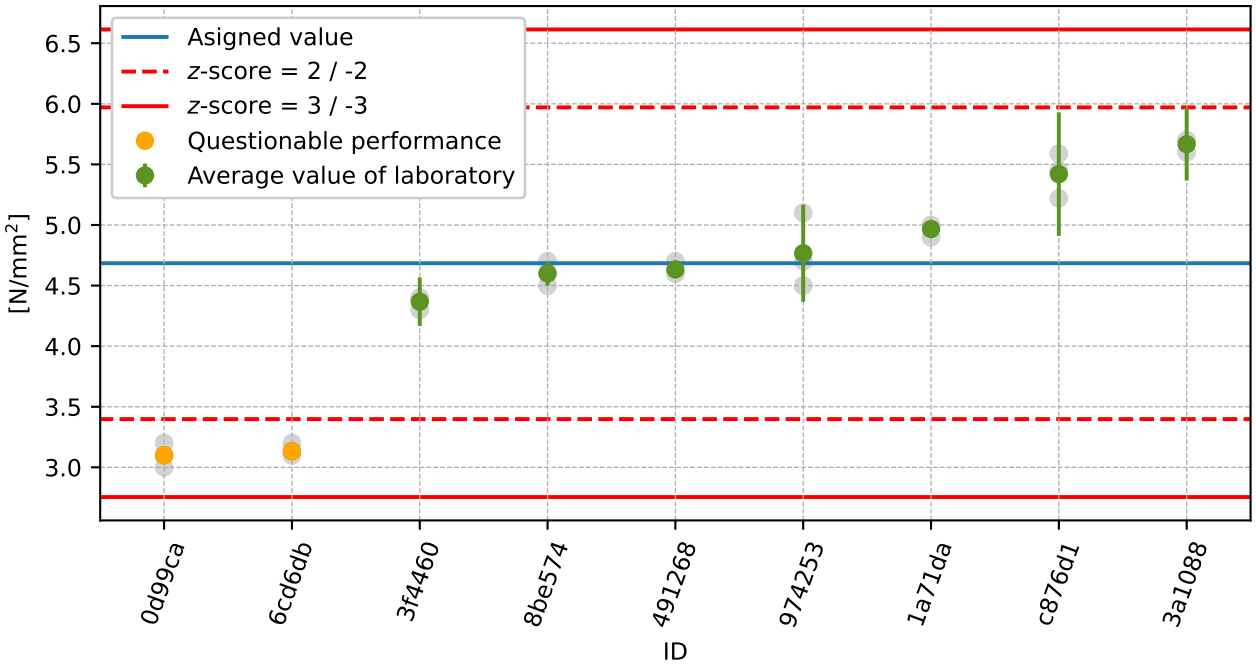

Figure 9: Average values and extended uncertainties of measurement

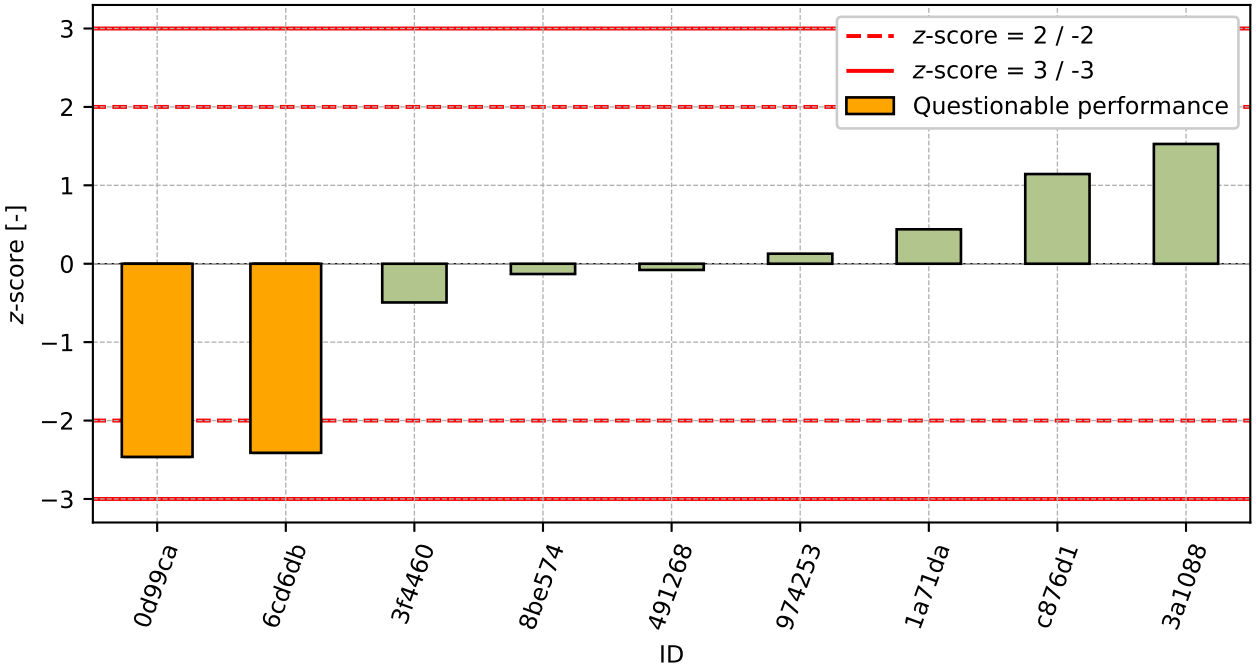

Figure 10: z-score

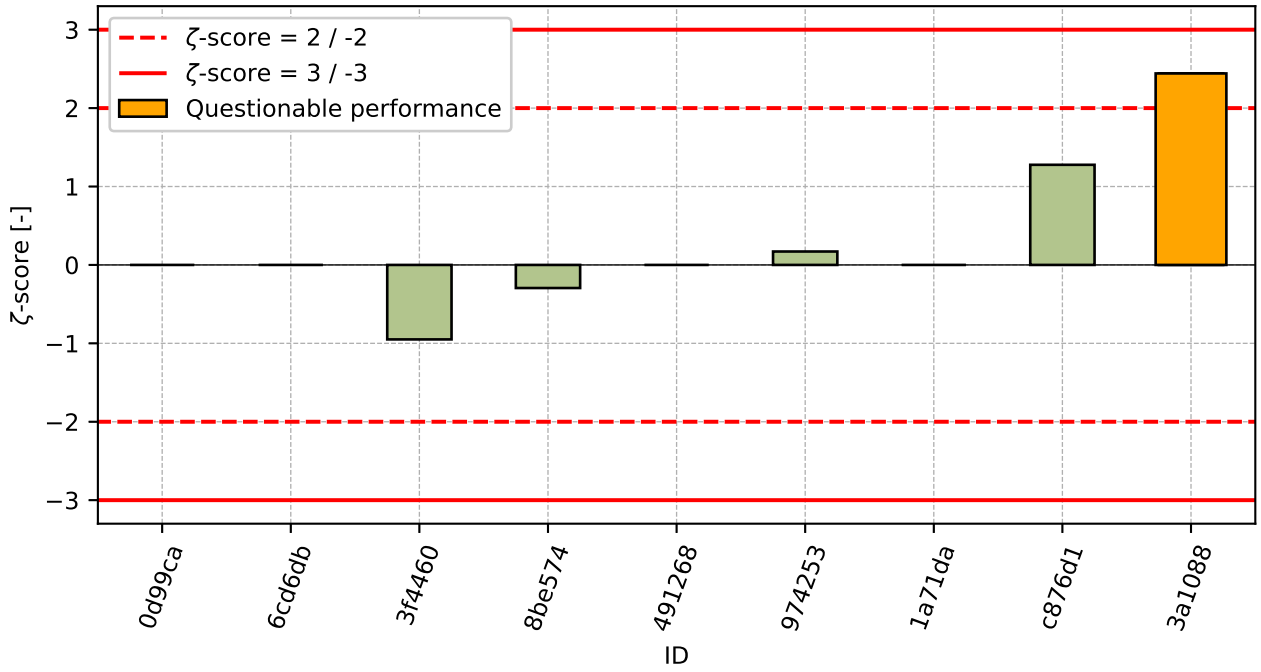

Figure 11: ζ-score

Table 6: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
0d99ca	-2.46	-
6cd6db	-2.41	-
3f4460	-0.49	-0.95
8be574	-0.13	-0.29
491268	-0.08	-
974253	0.13	0.17
1a71da	0.44	-
c876d1	1.14	1.28
3a1088	1.53	2.44

1.2 Compressive Strength after 2 days of ageing

1.2.1 Test results

Table 7: 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 [%]
ff9dcf	18.1	18.8	19.4	18.1	19.4	18.8	2.6	18.8	0.58	3.1
8be574	22.1	22.5	22.3	22.4	22.2	22.6	0.5	22.4	0.19	0.84
1a71da	24.4	23.4	23.5	23.4	23.5	22.7	-	23.5	0.54	2.31
3a1088	24.4	24.1	24.5	25.3	25.0	25.0	1.8	24.7	0.45	1.83
491268	24.9	24.2	25.6	25.3	24.8	24.7	-	24.9	0.49	1.96
974253	25.2	25.2	25.2	26.1	24.9	25.2	2.0	25.3	0.41	1.62
c876d1	25.9	25.8	26.0	26.2	25.9	25.7	0.3	25.9	0.17	0.66
6cd6db	27.0	25.9	27.3	26.7	27.7	26.3	-	26.8	0.66	2.46
0d99ca	27.3	26.1	27.6	26.3	27.3	26.8	-	26.9	0.6	2.24
3f4460	27.2	26.3	26.8	27.0	27.9	28.1	1.5	27.2	0.67	2.46

1.2.2 The Numerical Procedure for Determining Outliers

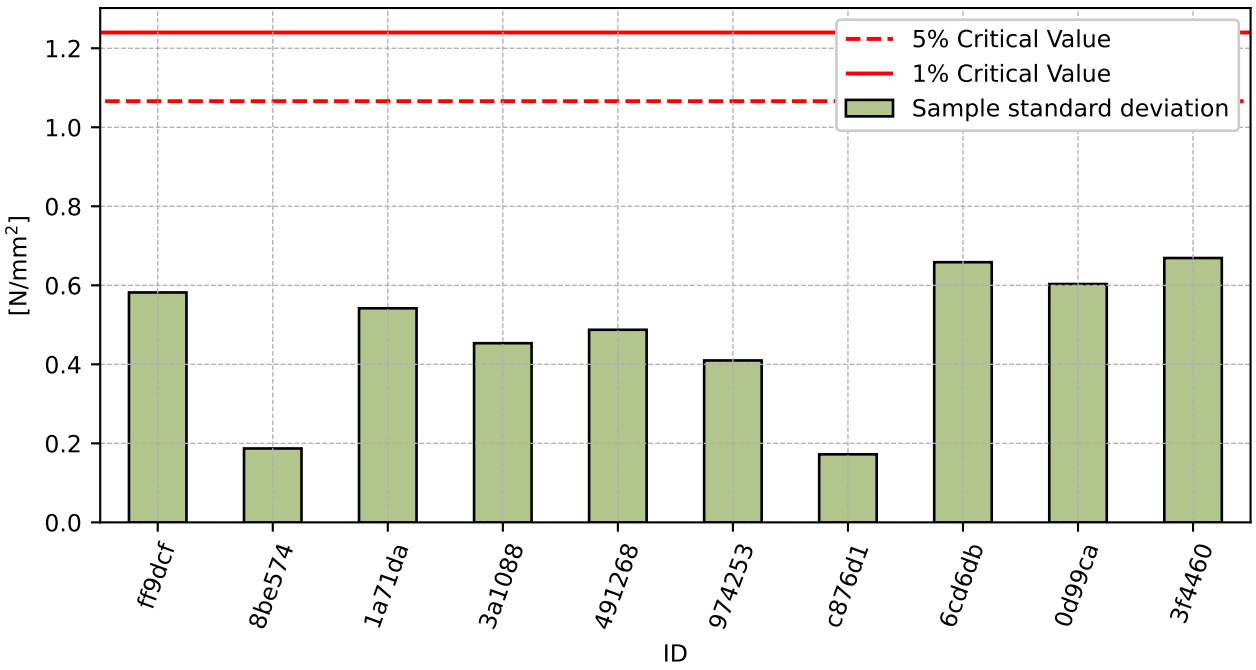

Figure 12: **Cochran's test** - sample standard deviations

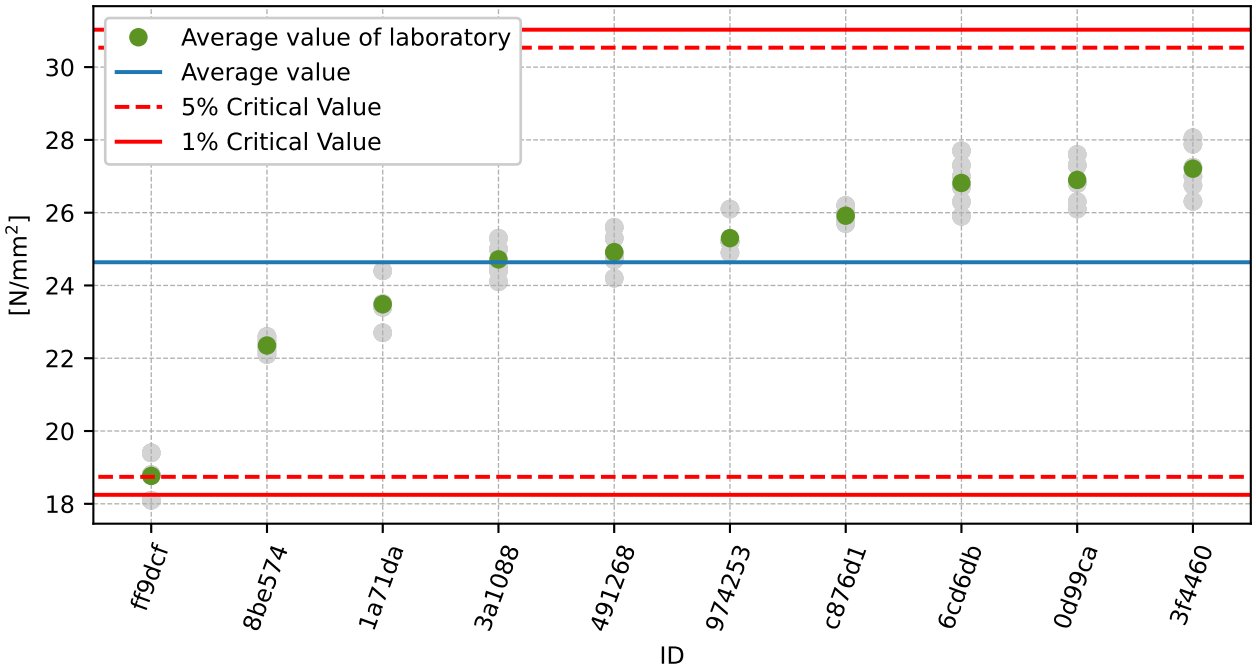

Figure 13: **Grubbs' test** - average values

1.2.3 Mandel's Statistics

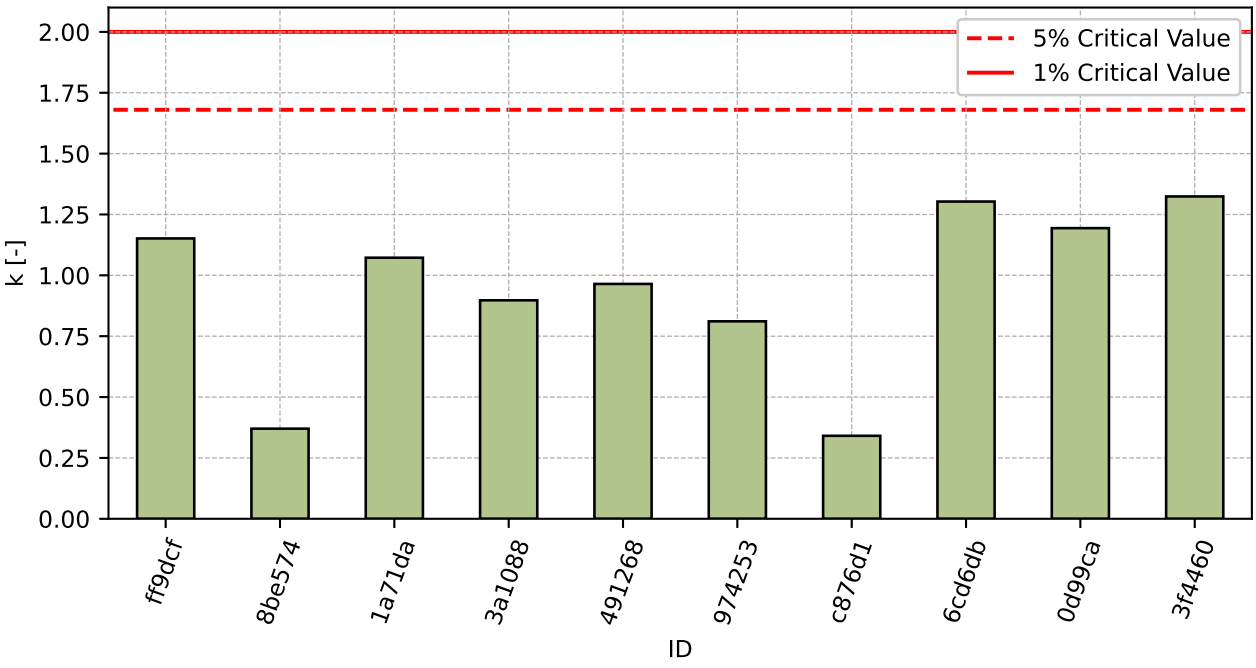

Figure 14: Intralaboratory Consistency Statistic

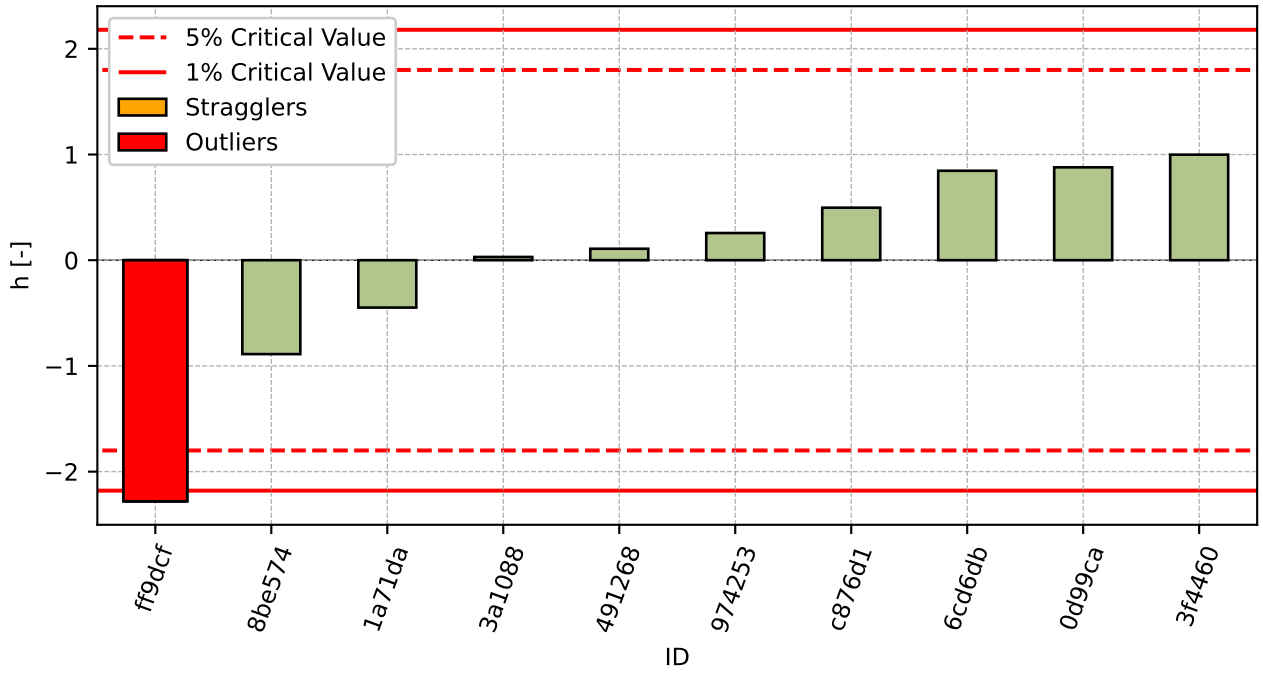

Figure 15: Interlaboratory Consistency Statistic

1.2.4 Descriptive statistics

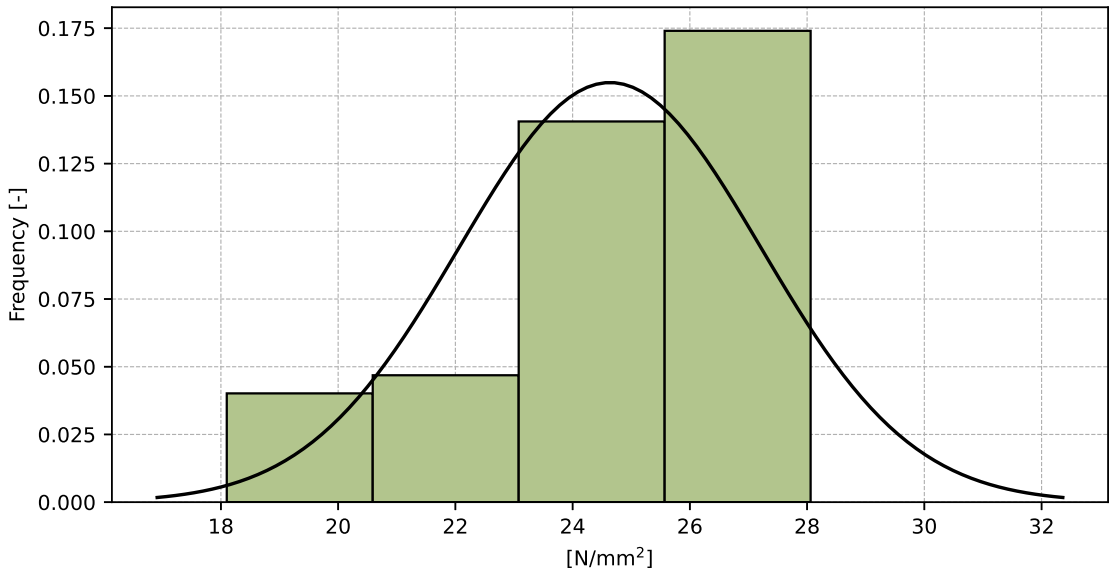

Figure 16: Histogram of all test results

Table 8: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	24.6
Sample standard deviation – s	2.57
Asigned value – x^*	25.0
Robust standard deviation – s^*	2.01
Measurement uncertainty of asigned value – u_X	0.8
p-value of normality test	0.002 [-]
Interlaboratory standard deviation – s_L	2.57
Repeatability standard deviation – s_r	0.51
Reproducibility standard deviation – s_R	2.62
Repeatability – r	1.4
Reproducibility – R	7.3

1.2.5 Evaluation of Performance Statistics

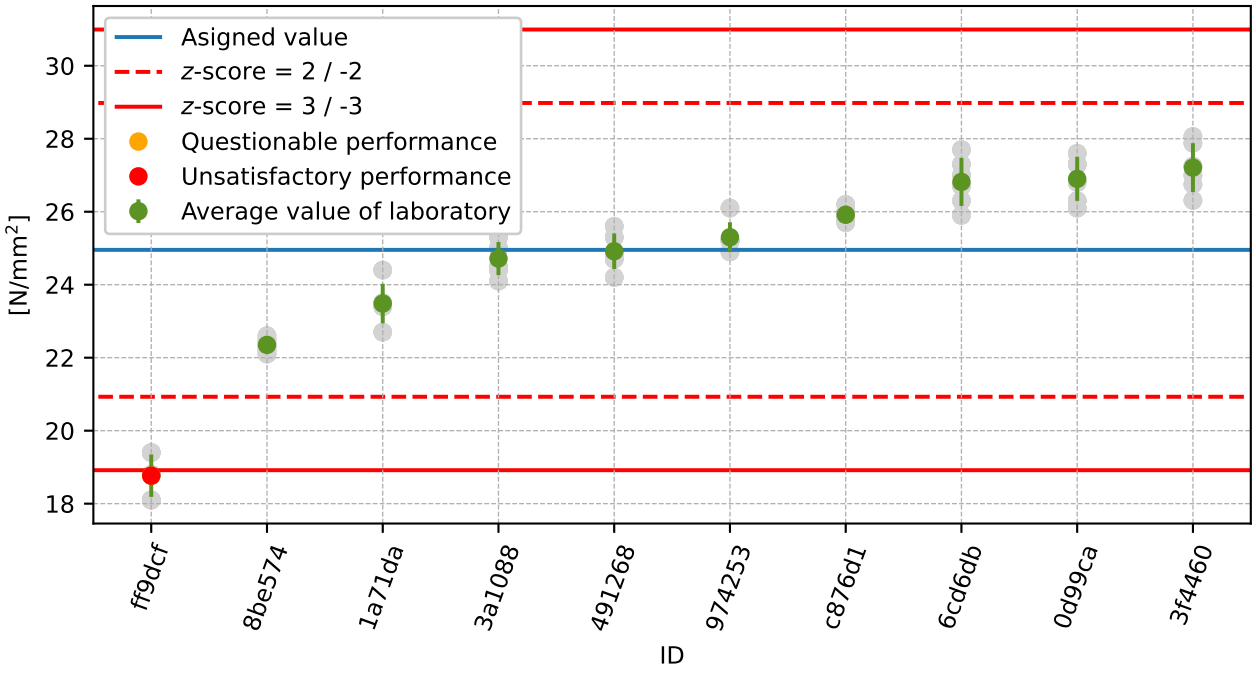

Figure 17: Average values and sample standard deviations

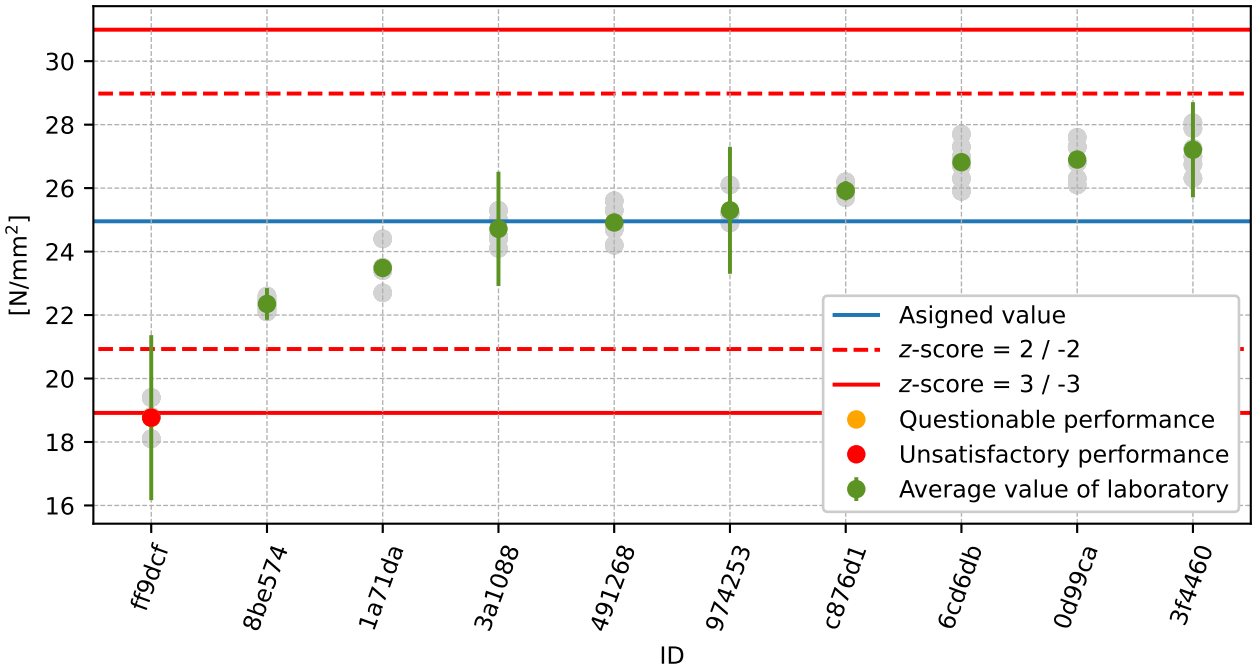

Figure 18: Average values and extended uncertainties of measurement

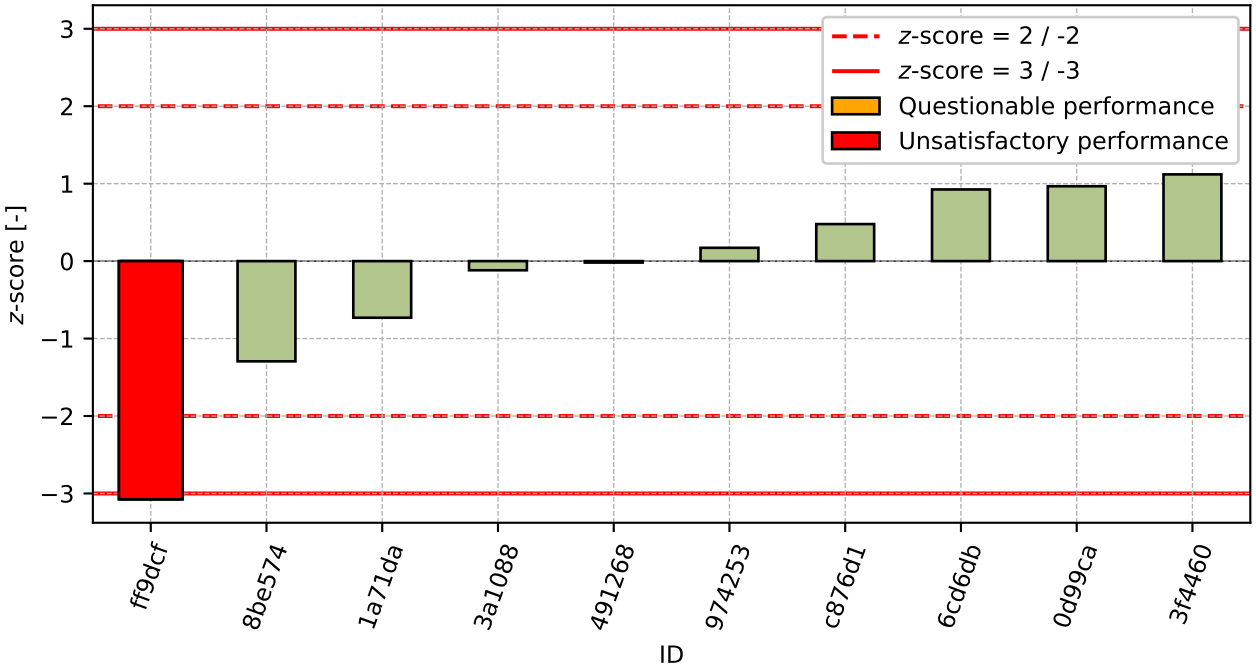

Figure 19: z-score

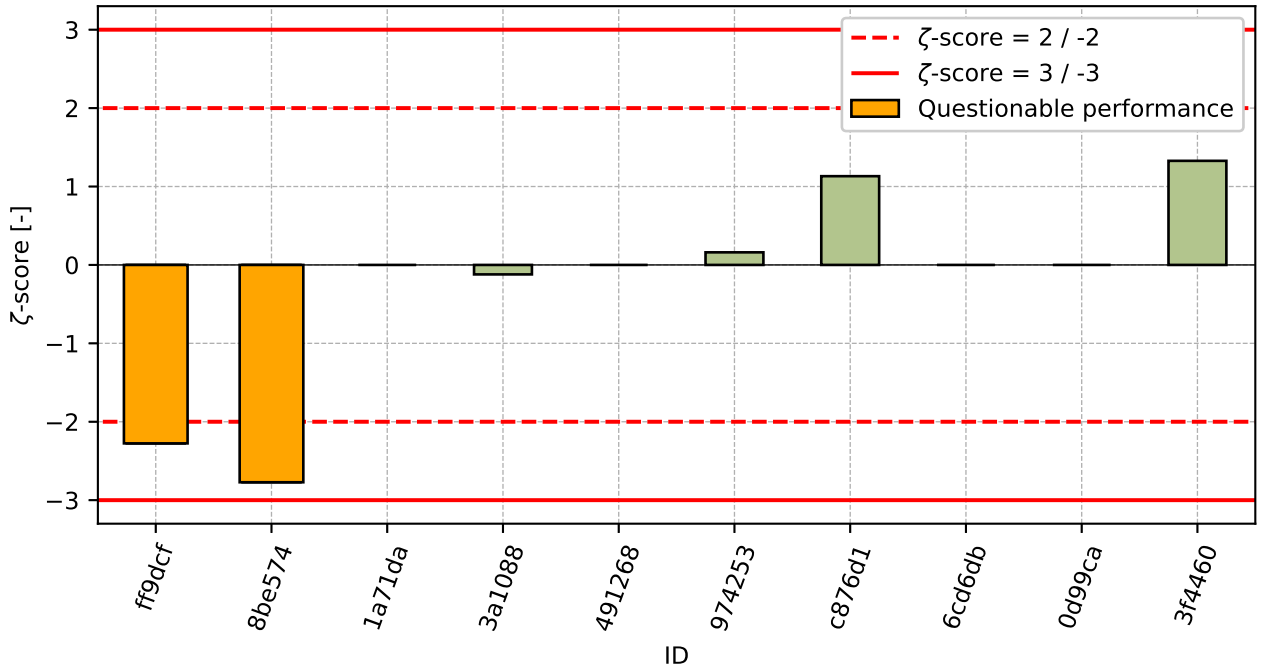

Figure 20: ζ-score

Table 9: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
ff9dcf	-3.07	-2.28
8be574	-1.29	-2.77
1a71da	-0.73	-
3a1088	-0.12	-0.12
491268	-0.02	-
974253	0.17	0.16
c876d1	0.48	1.13
6cd6db	0.93	-
0d99ca	0.97	-
3f4460	1.12	1.33

1.3 Flexural Strength after 7 days of ageing

1.3.1 Test results

Table 10: 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 [%]
0d99ca	3.6	3.5	3.9	-	3.7	0.21	5.68
6cd6db	3.7	3.9	4.0	-	3.9	0.15	3.95
8be574	5.6	5.8	5.7	0.1	5.7	0.1	1.75
3f4460	6.7	6.4	6.8	0.3	6.6	0.21	3.14
974253	6.9	7.2	6.4	0.5	6.8	0.4	5.91
1a71da	6.9	6.6	7.0	-	6.8	0.21	3.05
c876d1	7.0	6.8	7.1	0.4	7.0	0.14	2.01
491268	7.2	6.9	7.3	-	7.1	0.21	2.92
3a1088	8.8	8.9	9.1	0.5	8.9	0.15	1.71
ff9dcf	13.8	12.4	12.9	1.9	13.0	0.71	5.44

1.3.2 The Numerical Procedure for Determining Outliers

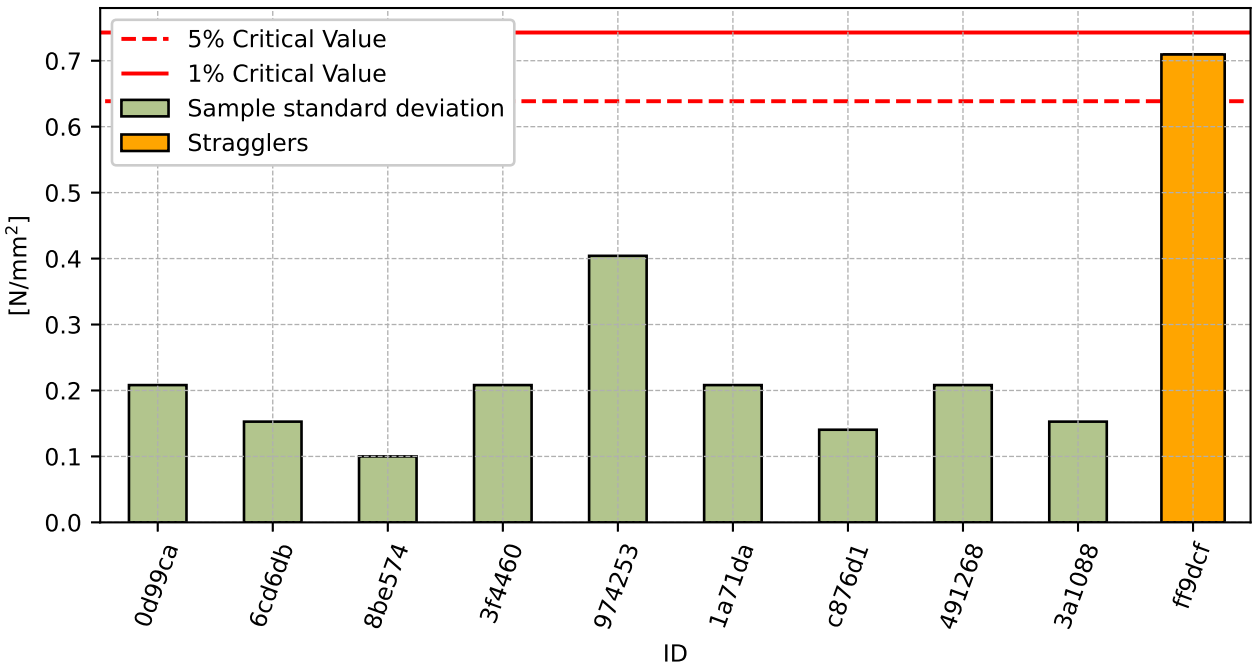

Figure 21: **Cochran's test** - sample standard deviations

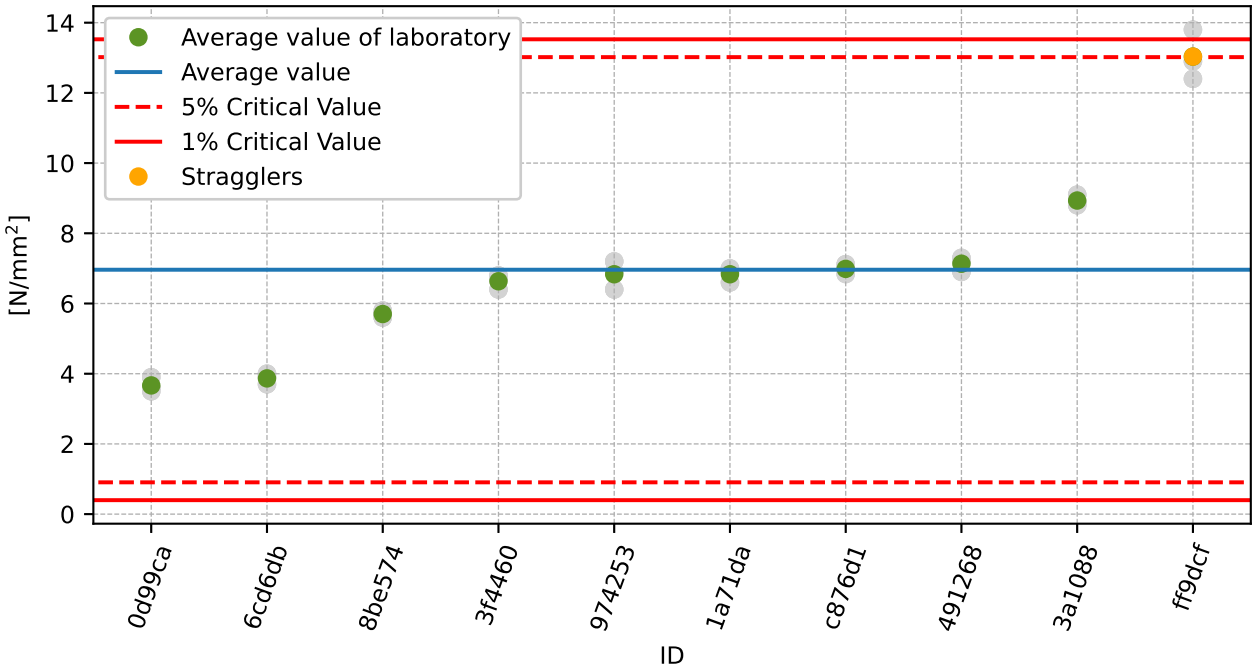

Figure 22: **Grubbs' test** - average values

1.3.3 Mandel's Statistics

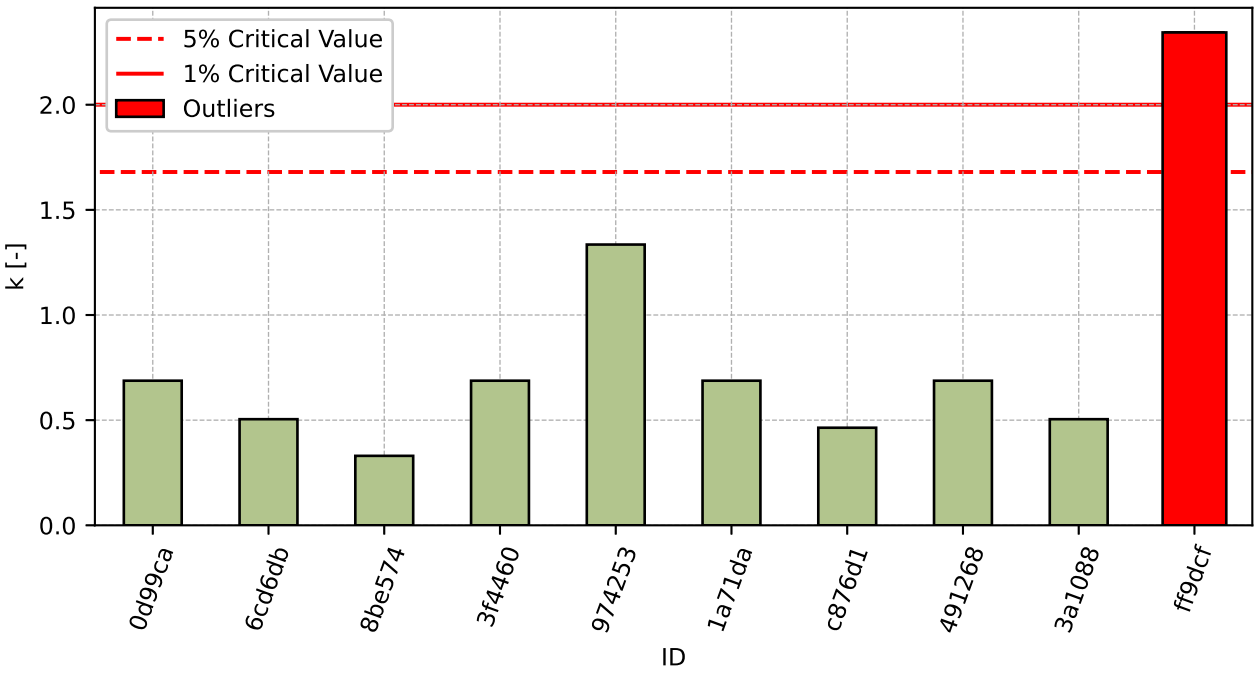

Figure 23: Intralaboratory Consistency Statistic

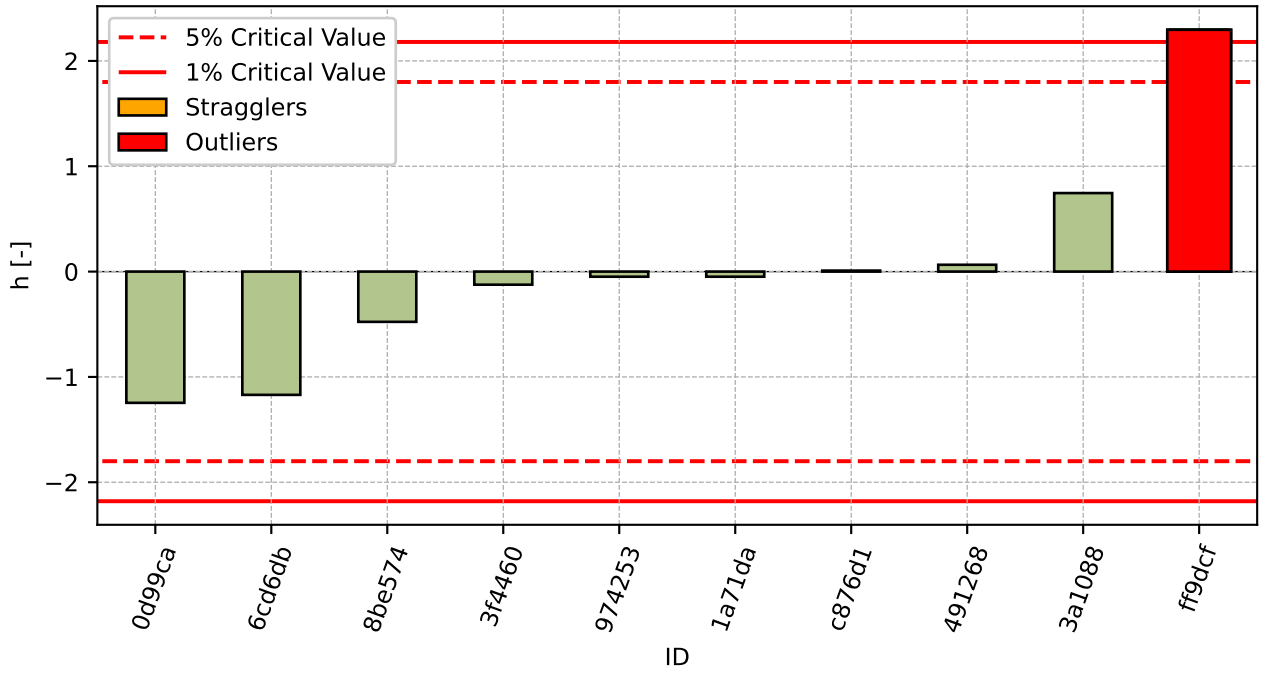

Figure 24: Interlaboratory Consistency Statistic

1.3.4 Descriptive statistics

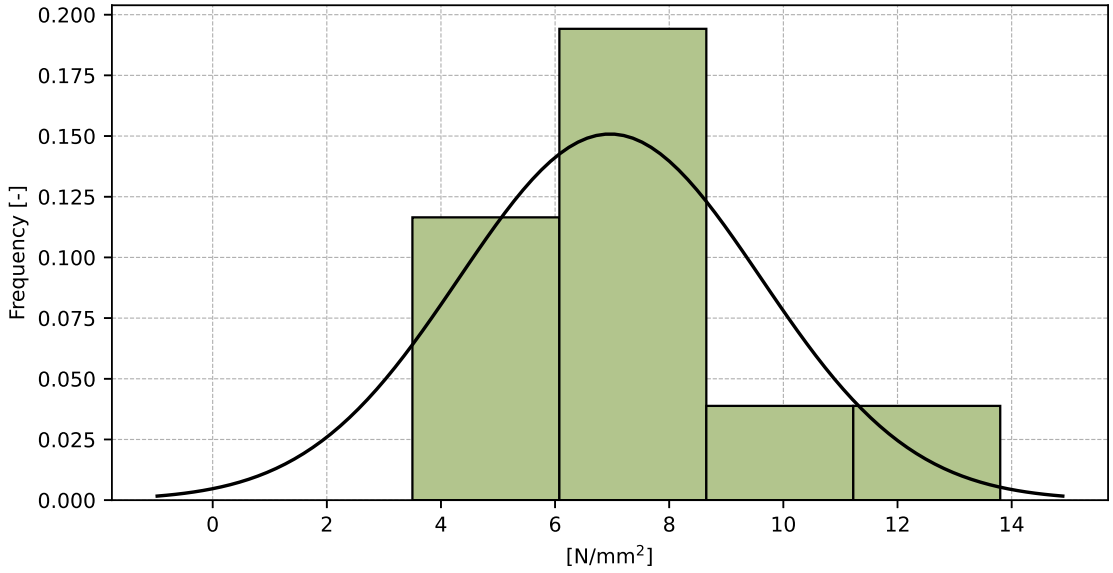

Figure 25: Histogram of all test results

Table 11: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	7.0
Sample standard deviation – s	2.64
Asigned value – x^*	7.2
Robust standard deviation – s^*	2.44
Measurement uncertainty of asigned value – u_X	0.96
p-value of normality test	0.012 [-]
Interlaboratory standard deviation – s_L	2.64
Repeatability standard deviation – s_r	0.3
Reproducibility standard deviation – s_R	2.66
Repeatability – r	0.8
Reproducibility – R	7.4

1.3.5 Evaluation of Performance Statistics

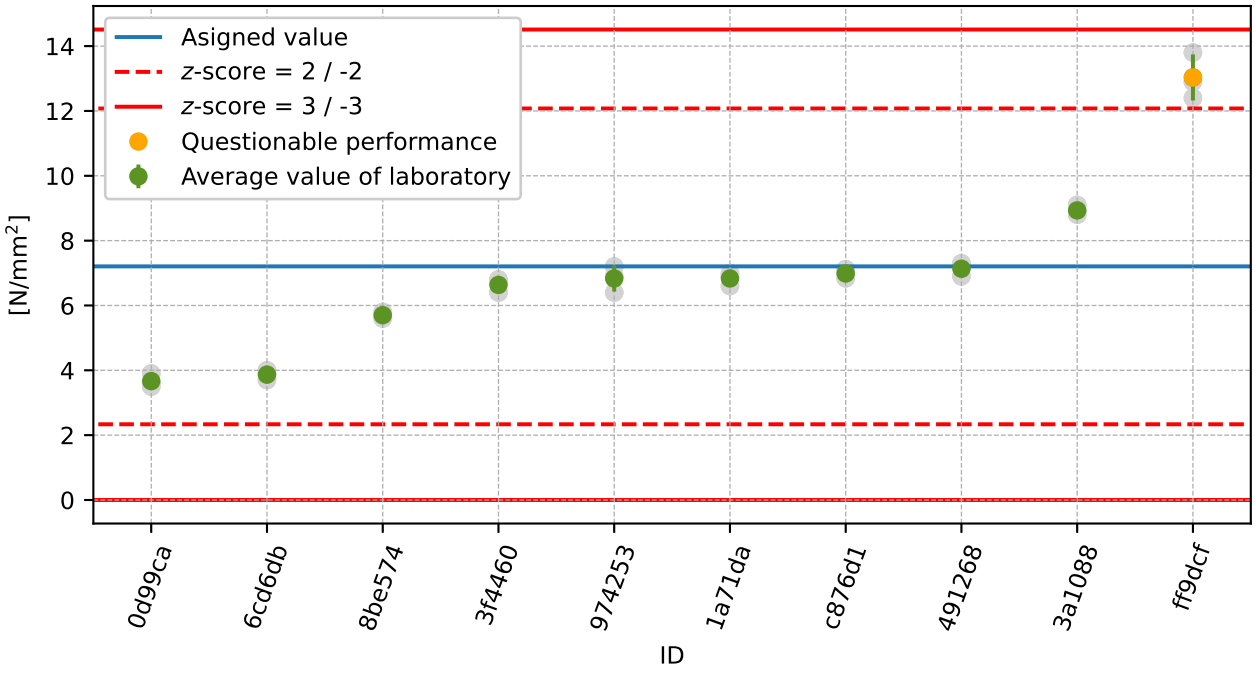

Figure 26: Average values and sample standard deviations

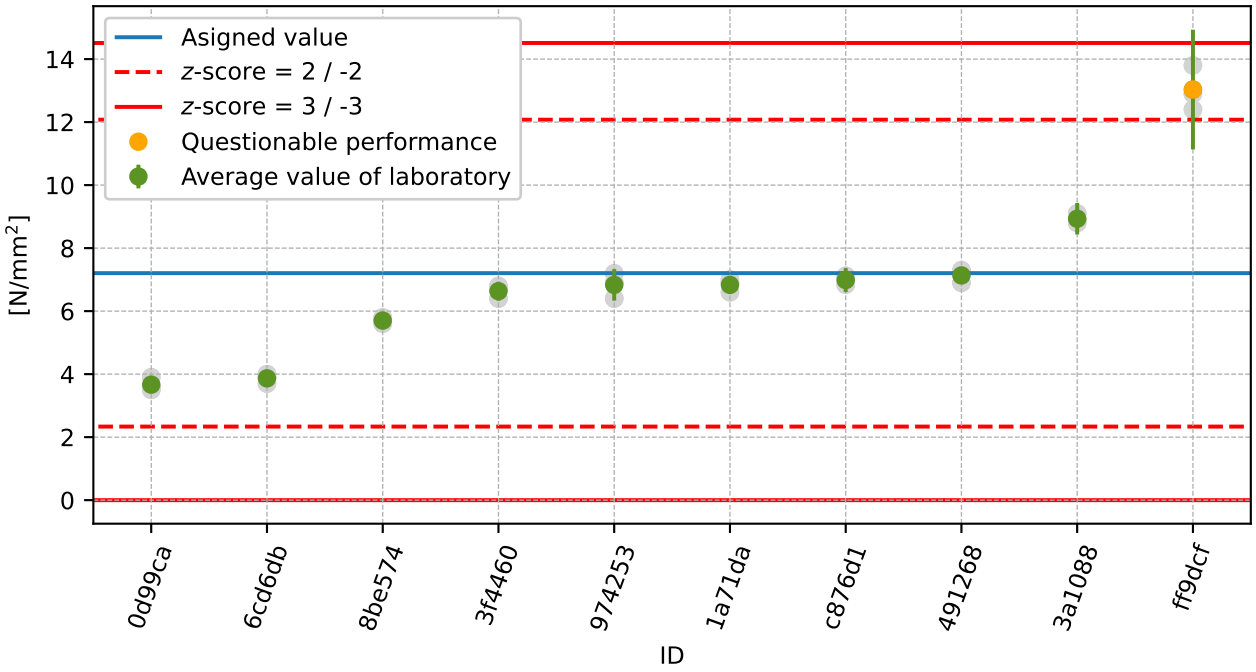

Figure 27: Average values and extended uncertainties of measurement

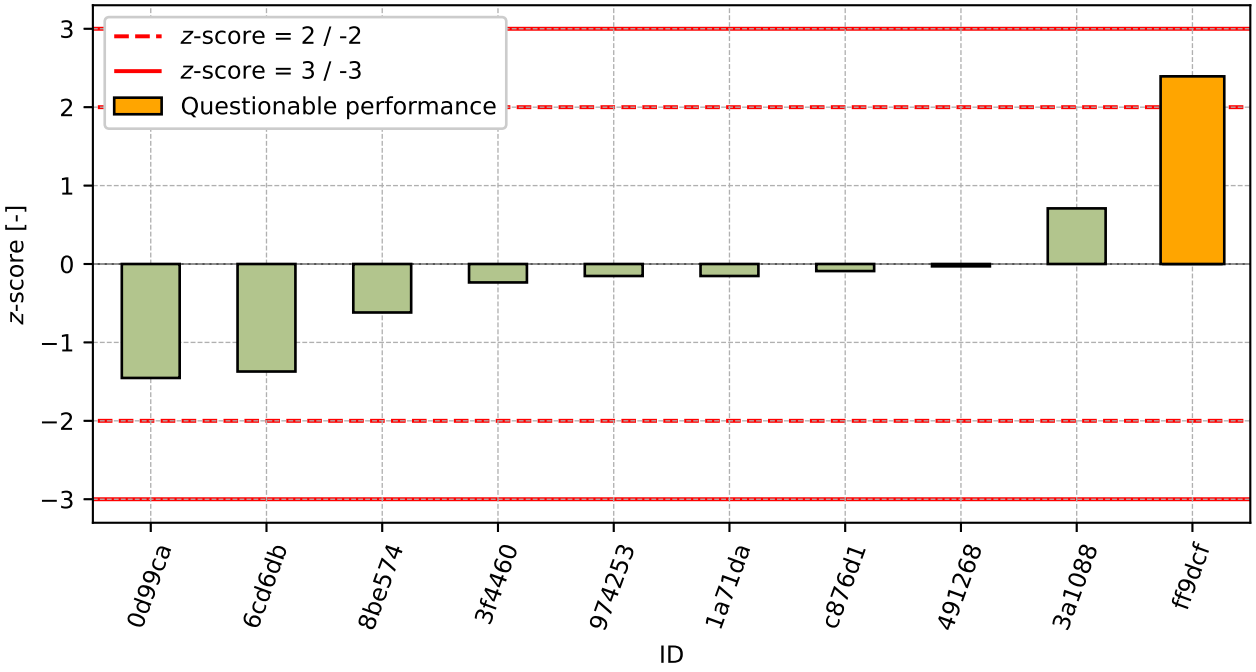

Figure 28: z-score

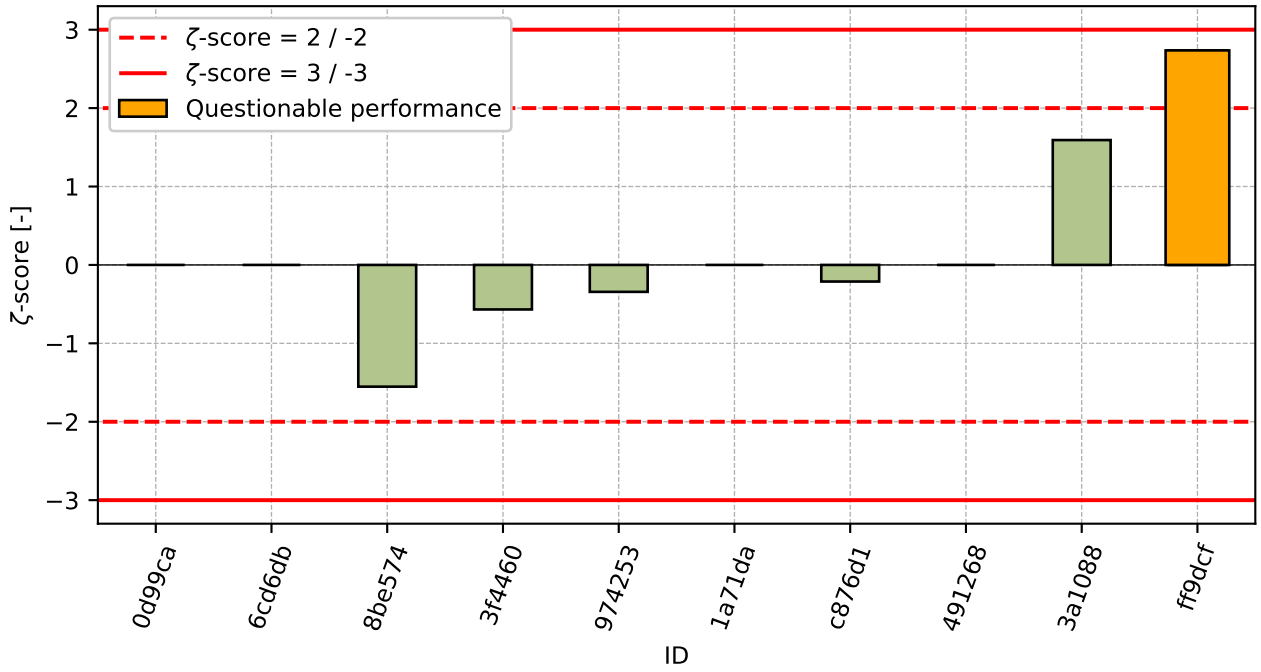

Figure 29: ζ-score

Table 12: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
0d99ca	-1.45	-
6cd6db	-1.37	-
8be574	-0.62	-1.55
3f4460	-0.24	-0.57
974253	-0.15	-0.34
1a71da	-0.15	-
c876d1	-0.09	-0.21
491268	-0.03	-
3a1088	0.71	1.59
ff9dcf	2.39	2.74

1.4 Compressive Strength after 7 days of ageing

1.4.1 Test results

Table 13: 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 [%]
ff9dcf	36.3	36.3	35.6	36.3	35.6	37.5	2.6	36.3	0.69	1.92
8be574	36.4	36.7	36.5	36.6	36.8	36.7	0.7	36.6	0.15	0.4
1a71da	41.5	39.9	40.7	39.8	40.0	39.4	-	40.2	0.76	1.88
c876d1	42.3	41.9	41.5	41.4	42.1	41.9	0.5	41.8	0.34	0.82
6cd6db	44.4	43.7	42.9	43.2	42.5	42.9	-	43.3	0.68	1.58
974253	44.6	43.2	44.9	46.1	42.9	43.2	2.5	44.2	1.26	2.85
3f4460	43.5	45.4	42.6	44.0	45.5	44.1	2.1	44.2	1.12	2.54
3a1088	44.0	44.3	43.5	44.0	44.5	45.3	3.2	44.3	0.61	1.38
0d99ca	46.9	44.6	46.1	44.7	48.1	45.7	-	46.0	1.34	2.91
491268	48.4	46.2	48.6	45.5	48.4	45.2	-	47.1	1.59	3.37

1.4.2 The Numerical Procedure for Determining Outliers

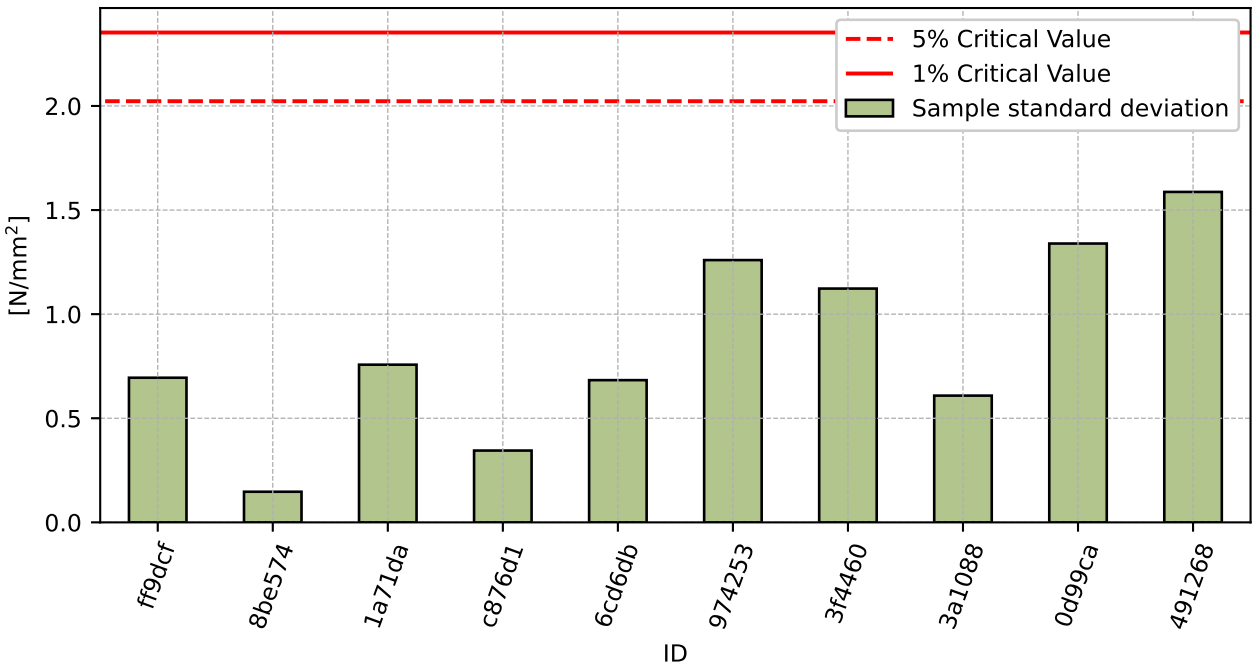

Figure 30: **Cochran's test** - sample standard deviations

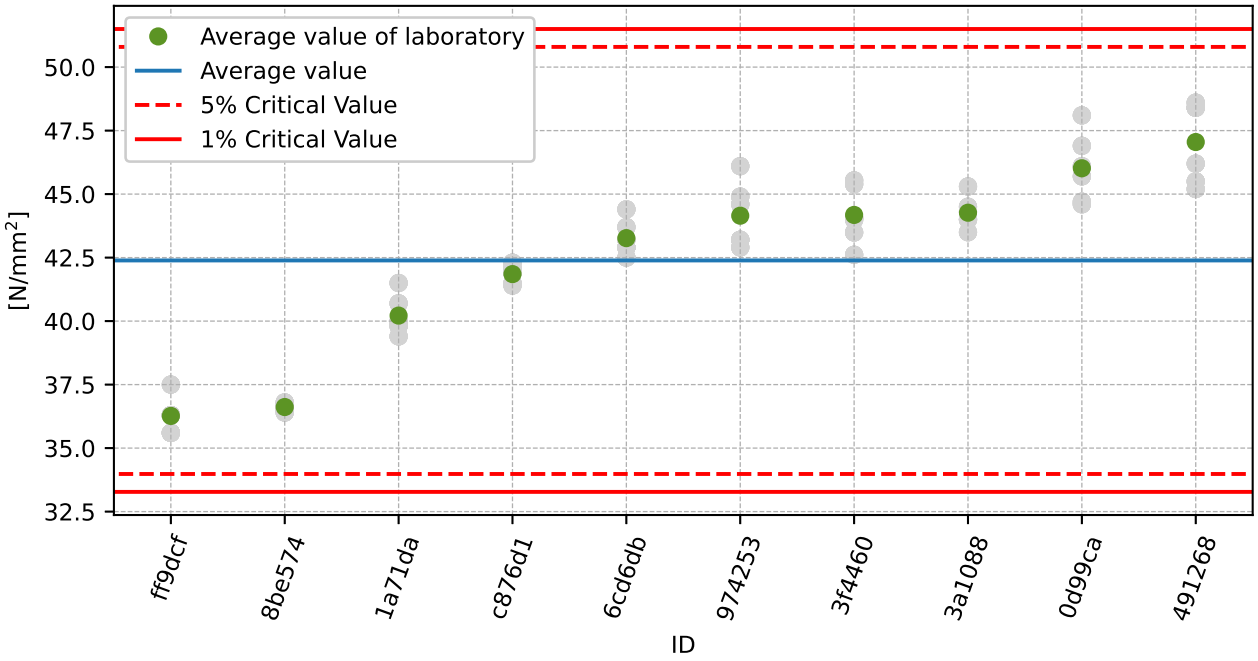

Figure 31: **Grubbs' test** - average values

1.4.3 Mandel's Statistics

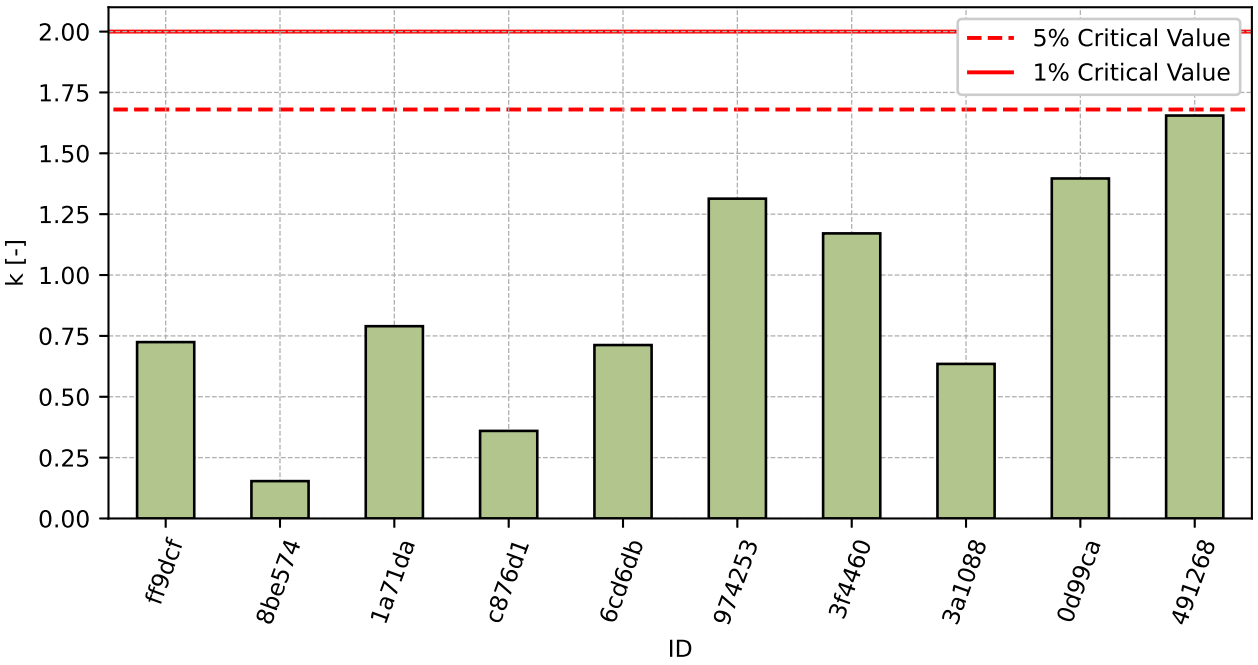

Figure 32: Intralaboratory Consistency Statistic

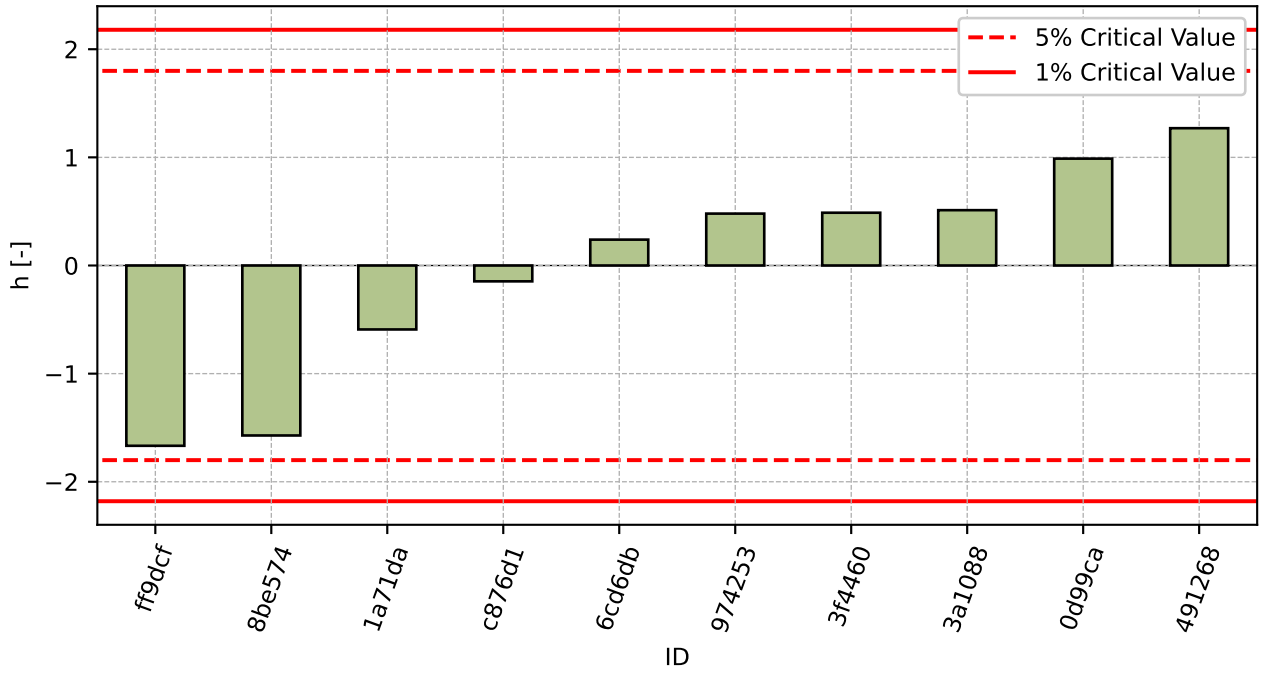

Figure 33: Interlaboratory Consistency Statistic

1.4.4 Descriptive statistics

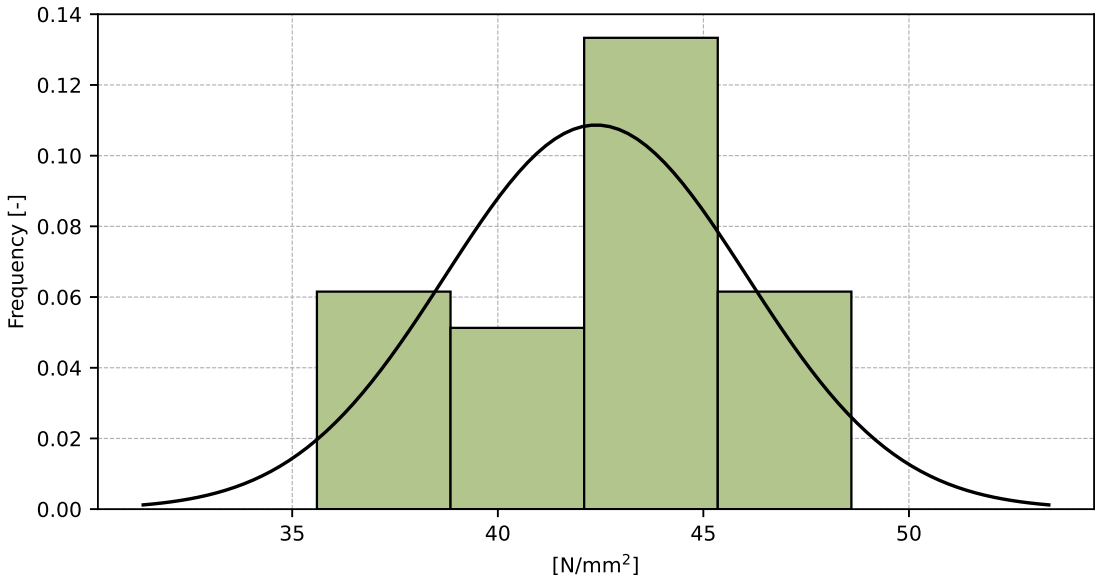

Figure 34: Histogram of all test results

Table 14: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	42.4
Sample standard deviation – s	3.67
Asigned value – x^*	42.9
Robust standard deviation – s^*	2.99
Measurement uncertainty of asigned value – u_X	1.18
p-value of normality test	0.113 [-]
Interlaboratory standard deviation – s_L	3.65
Repeatability standard deviation – s_r	0.96
Reproducibility standard deviation – s_R	3.77
Repeatability – r	2.7
Reproducibility – R	10.6

1.4.5 Evaluation of Performance Statistics

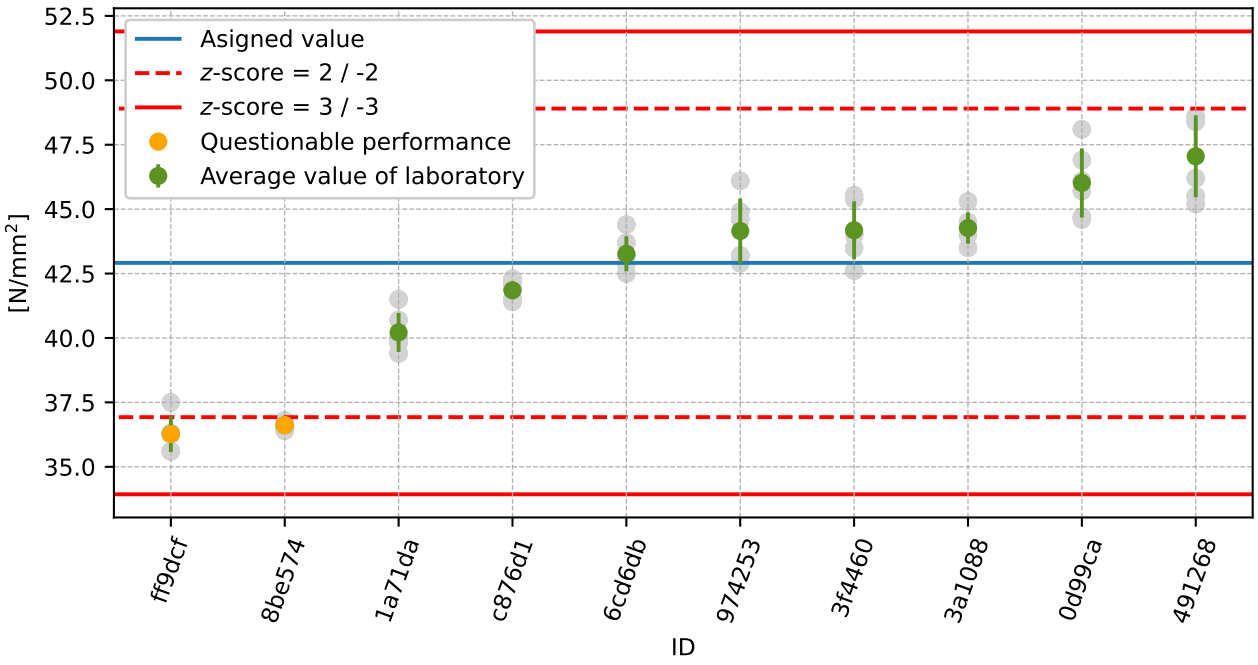

Figure 35: Average values and sample standard deviations

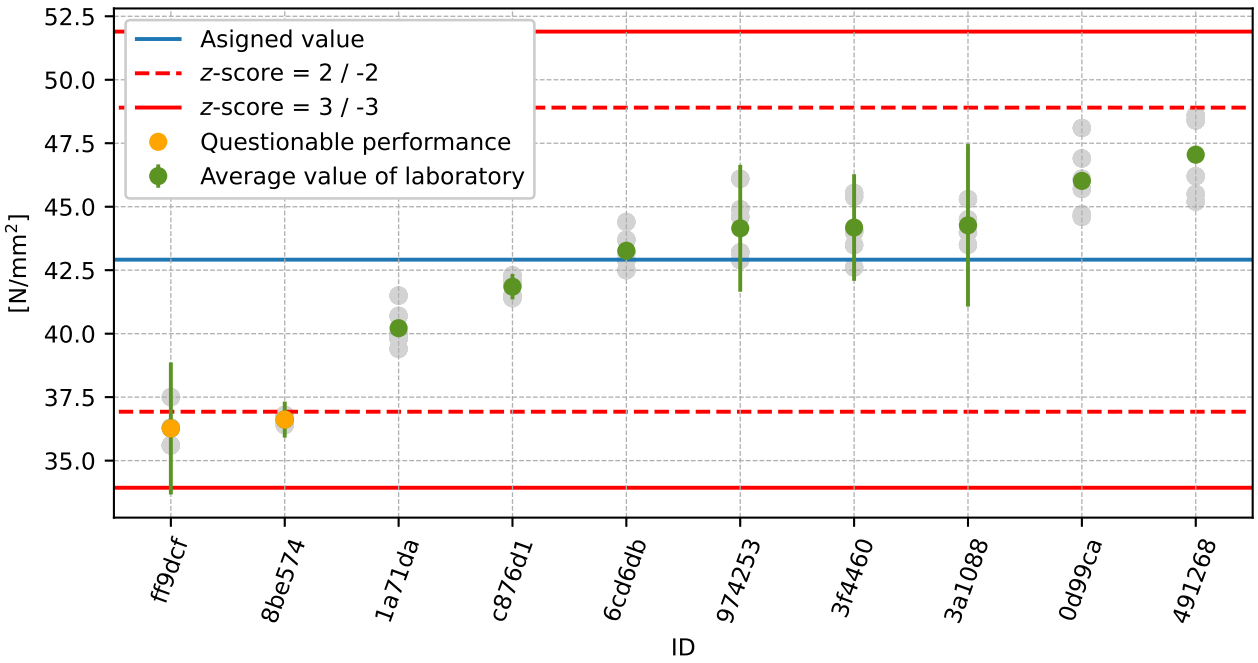

Figure 36: Average values and extended uncertainties of measurement

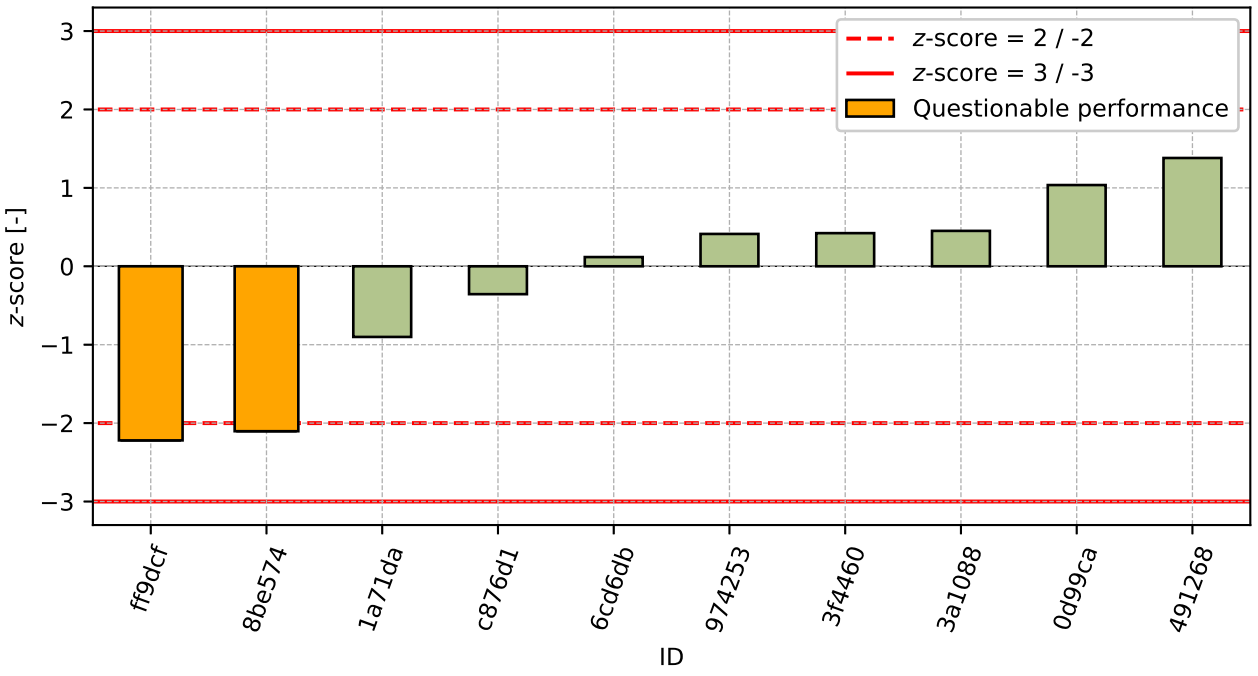

Figure 37: z-score

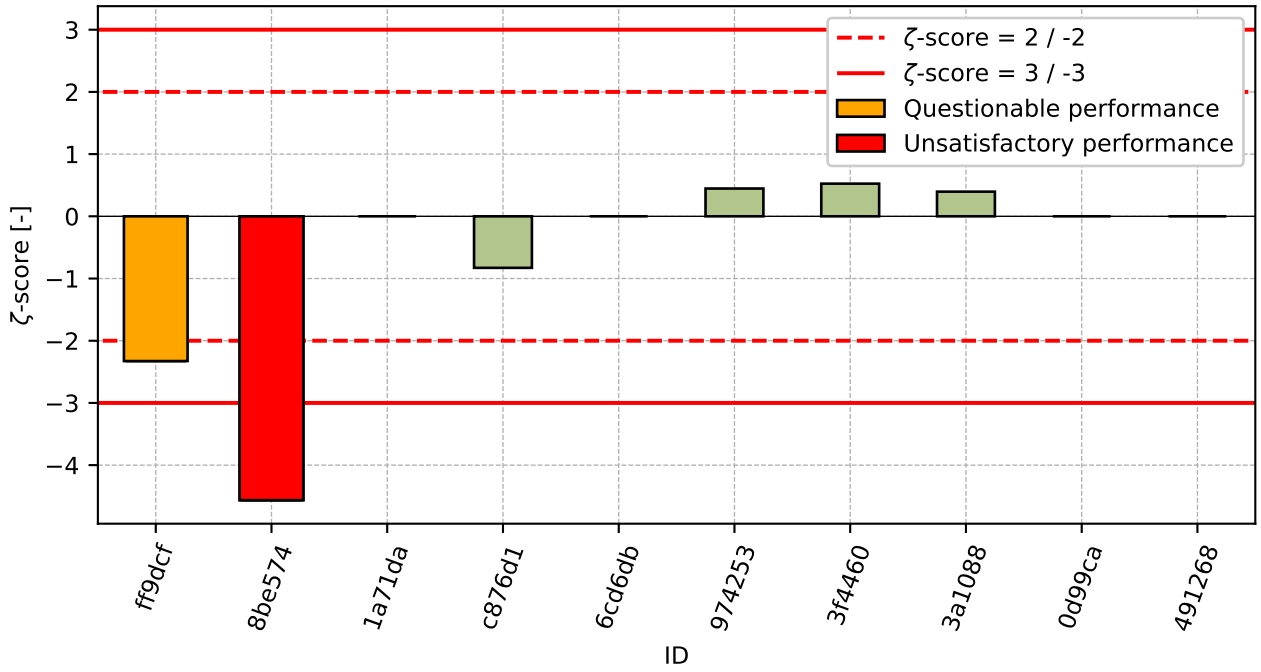

Figure 38: ζ-score

Table 15: *z*-score and ζ-score

ID	*z*-score [-]	ζ-score [-]
ff9dcf	-2.22	-2.33
8be574	-2.1	-4.56
1a71da	-0.9	-
c876d1	-0.36	-0.83
6cd6db	0.12	-
974253	0.41	0.45
3f4460	0.42	0.52
3a1088	0.45	0.4
0d99ca	1.04	-
491268	1.38	-

1.5 Flexural Strength after 28 days of ageing

1.5.1 Test results

Table 16: 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 [%]
0d99ca	5.5	5.9	4.9	-	5.4	0.5	9.26
6cd6db	5.7	6.0	5.0	-	5.6	0.51	9.22
8be574	6.9	7.1	7.0	0.2	7.0	0.1	1.43
3f4460	7.3	7.8	7.2	0.3	7.4	0.32	4.32
974253	8.6	6.8	7.8	0.7	7.7	0.9	11.66
1a71da	8.6	8.4	8.2	-	8.4	0.2	2.38
c876d1	8.6	8.4	8.5	0.3	8.5	0.11	1.24
491268	8.9	8.0	9.4	-	8.8	0.71	8.09
3a1088	9.9	10.4	9.8	0.5	10.0	0.32	3.2
ff9dcf	16.9	13.6	13.8	1.9	14.8	1.85	12.53

1.5.2 The Numerical Procedure for Determining Outliers

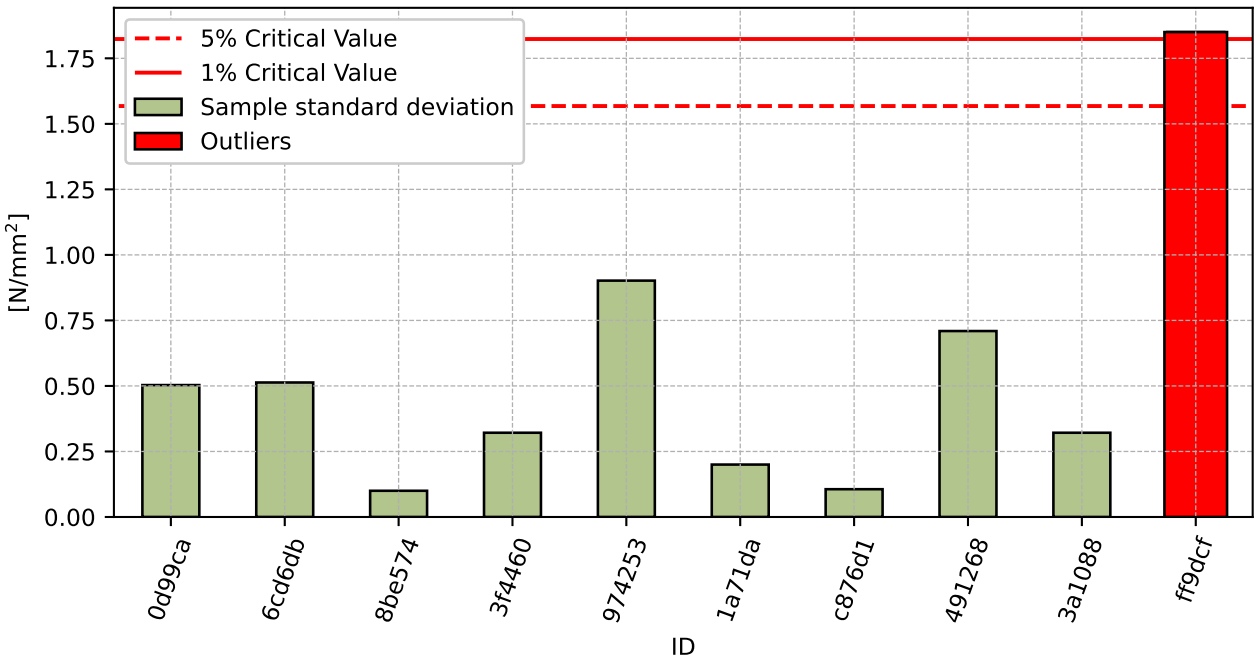

Figure 39: **Cochran's test** - sample standard deviations

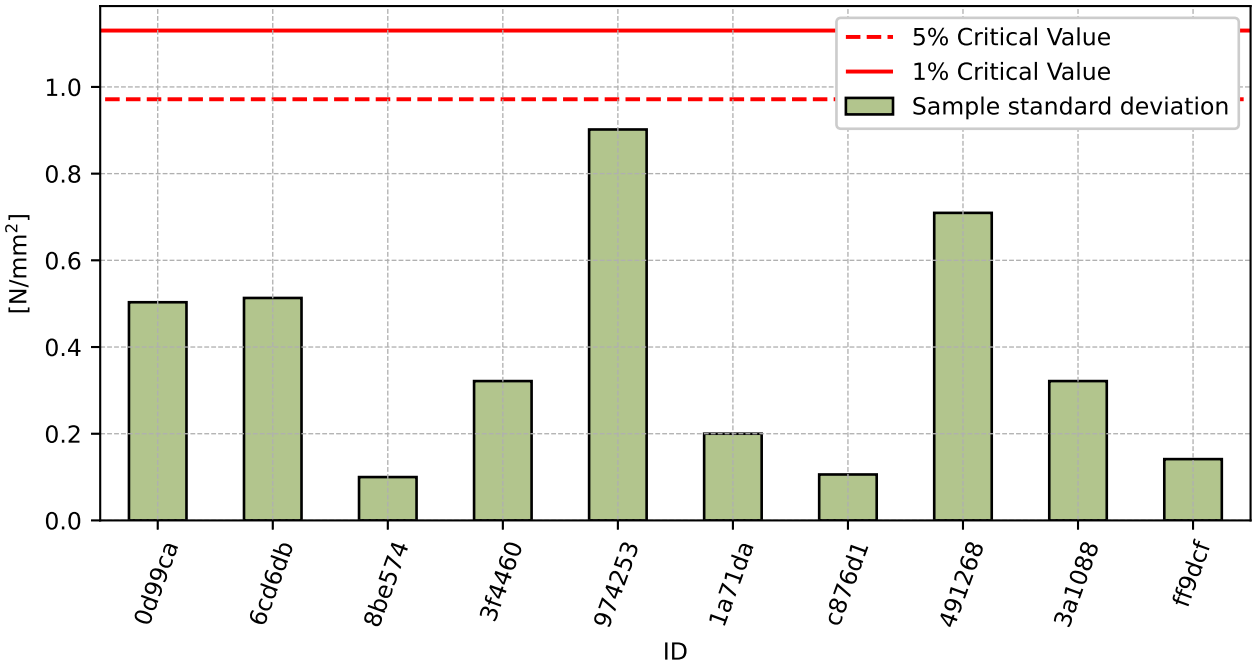

Figure 40: **Cochran's test** - sample standard deviations without outliers

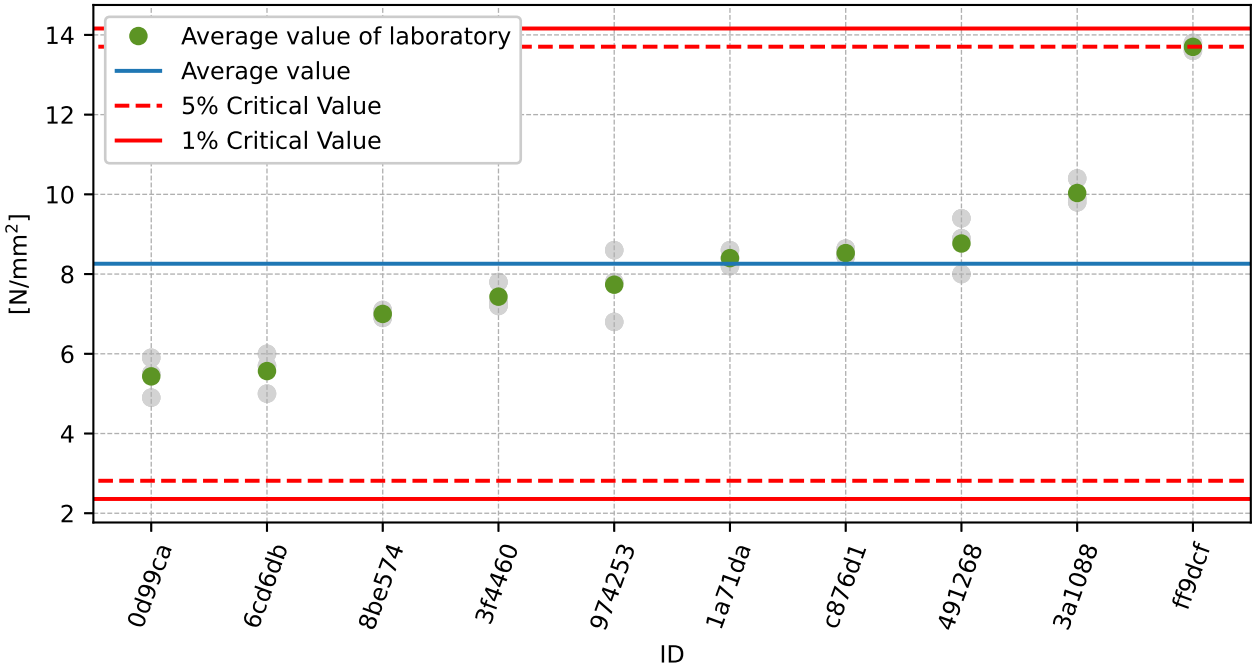

Figure 41: **Grubbs' test** - average values

1.5.3 Mandel's Statistics

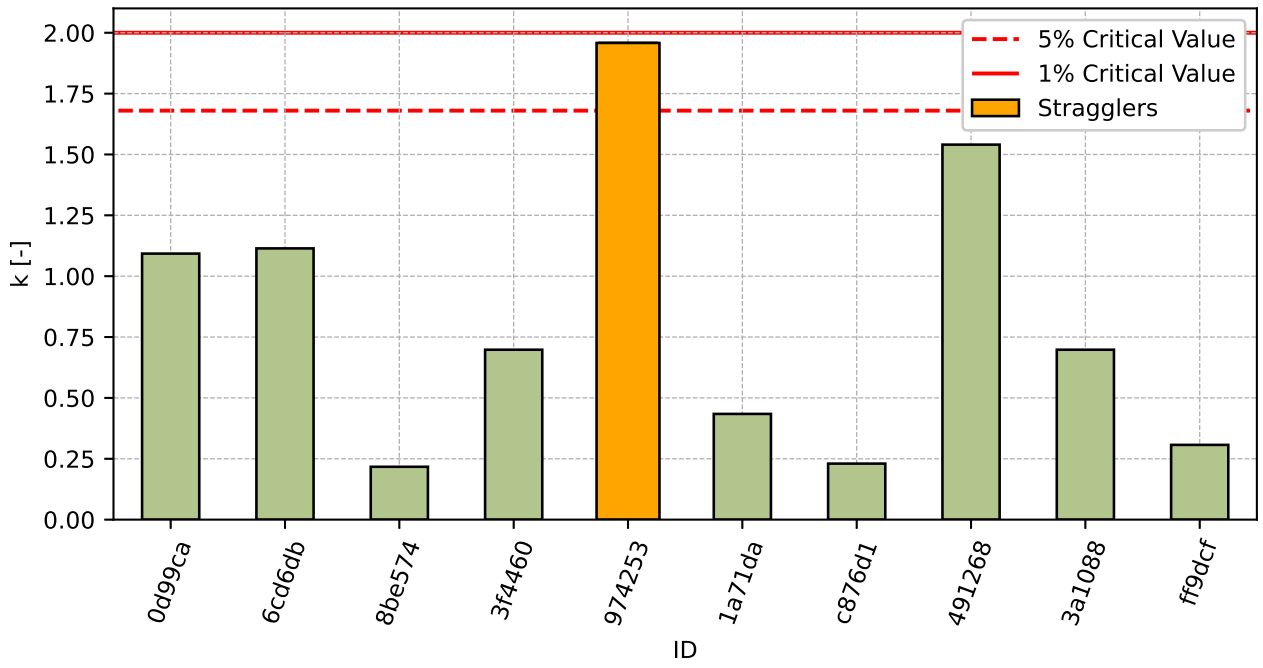

Figure 42: Intralaboratory Consistency Statistic

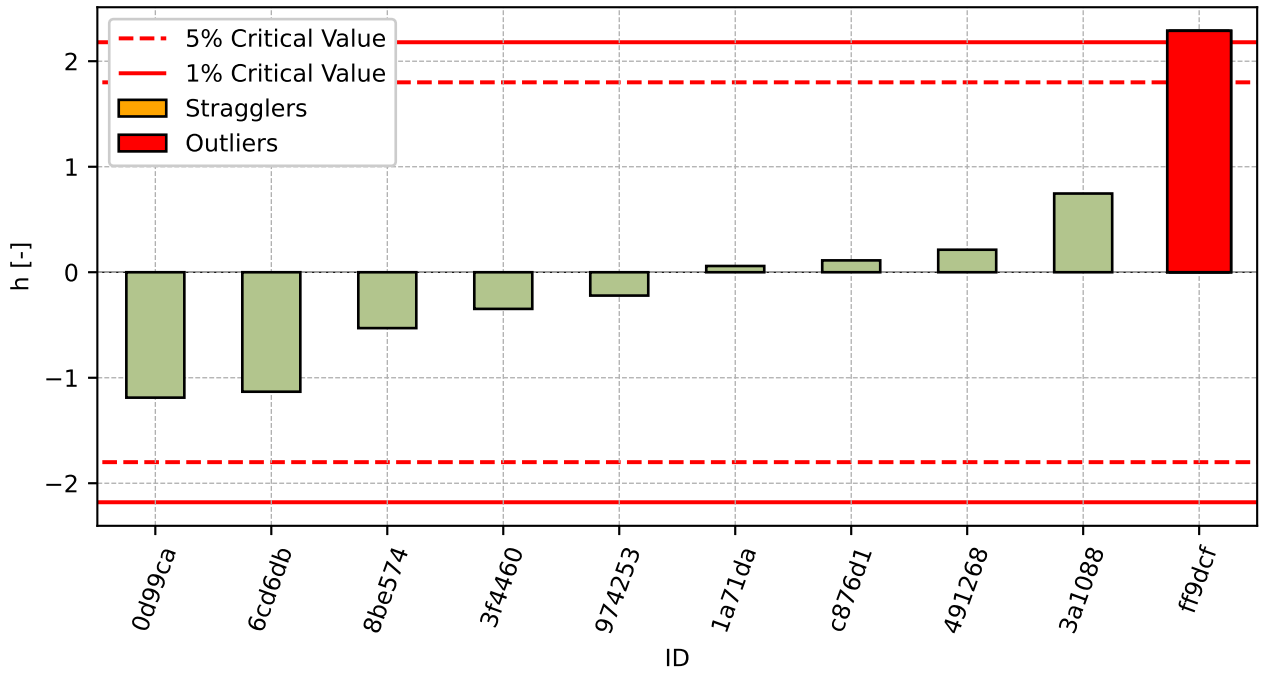

Figure 43: Interlaboratory Consistency Statistic

1.5.4 Descriptive statistics

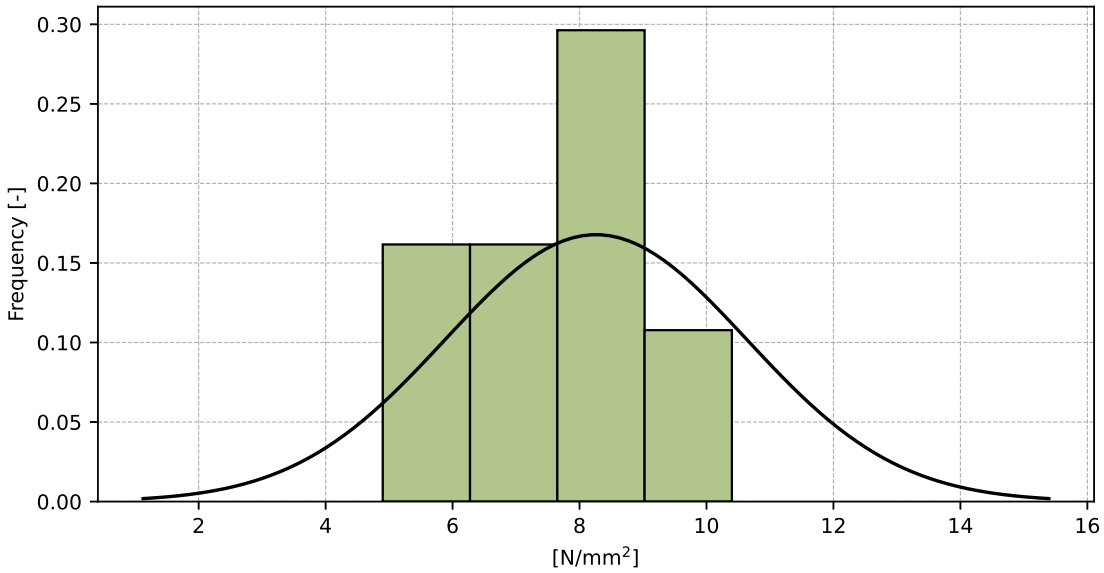

Figure 44: Histogram of all test results

Table 17: Descriptive statistics

Characteristics	[N/mm²]
Average value – $\bar{x}$	8.3
Sample standard deviation – s	2.38
Asigned value – x^*	8.4
Robust standard deviation – s^*	2.4
Measurement uncertainty of asigned value – u_X	0.95
p-value of normality test	0.658 [-]
Interlaboratory standard deviation – s_L	2.36
Repeatability standard deviation – s_r	0.46
Reproducibility standard deviation – s_R	2.41
Repeatability – r	1.3
Reproducibility – R	6.7

1.5.5 Evaluation of Performance Statistics

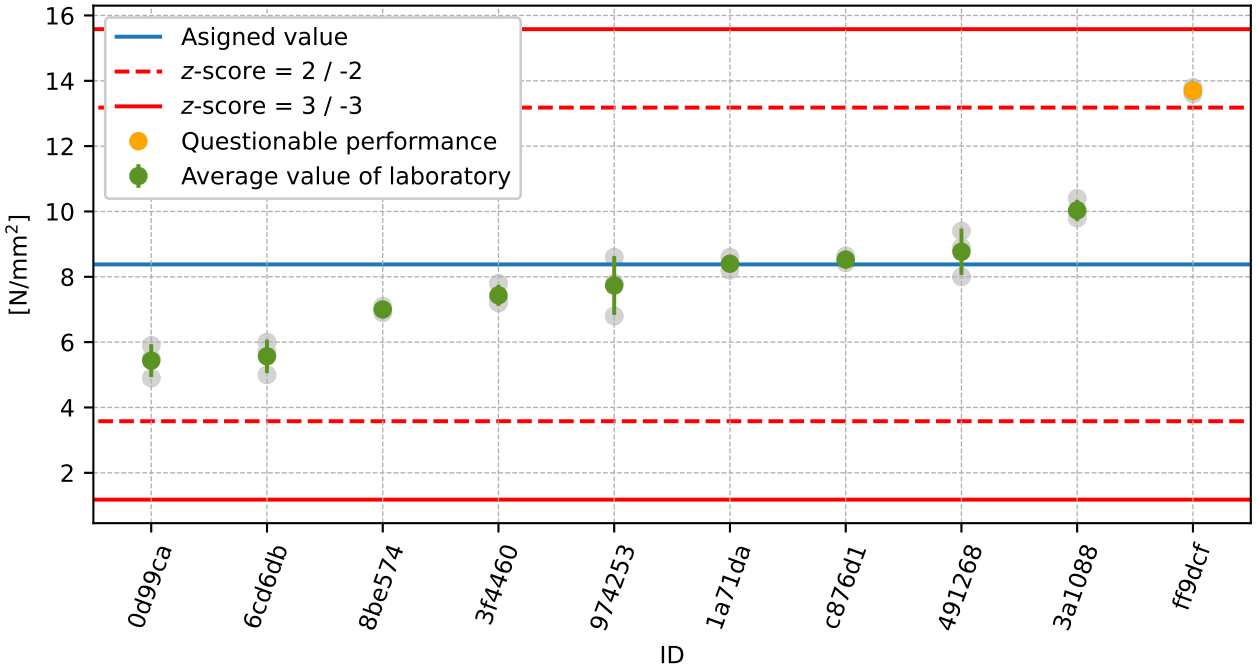

Figure 45: Average values and sample standard deviations

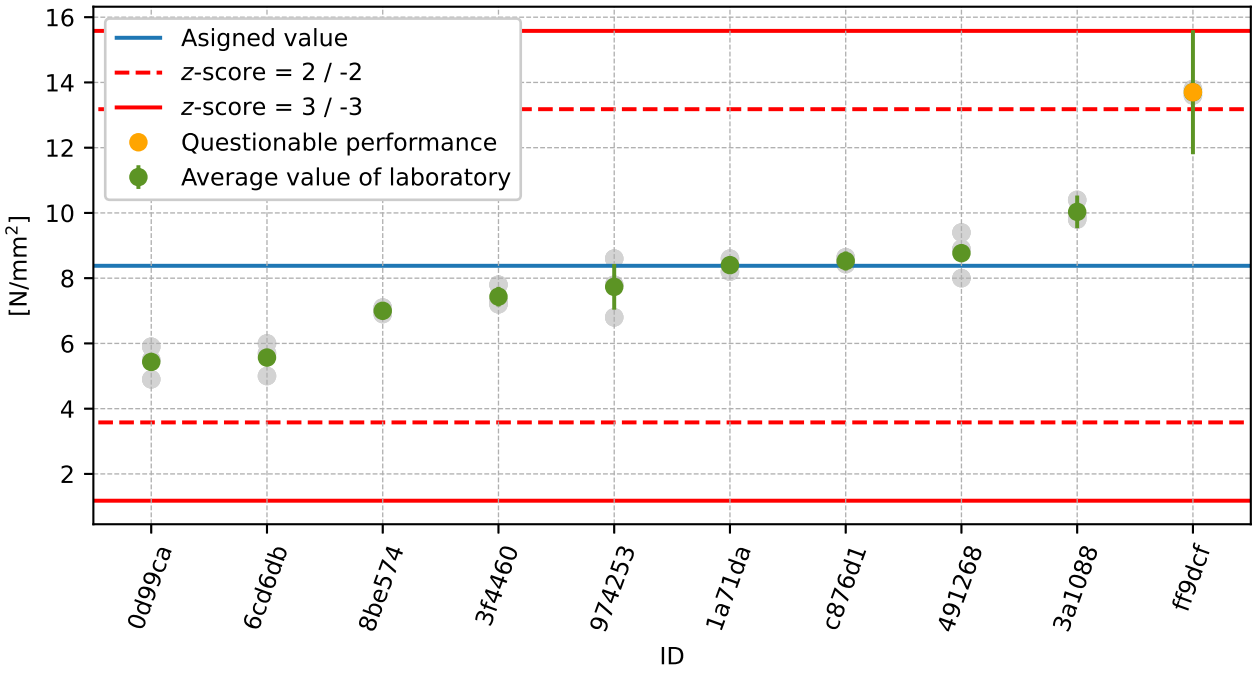

Figure 46: Average values and extended uncertainties of measurement

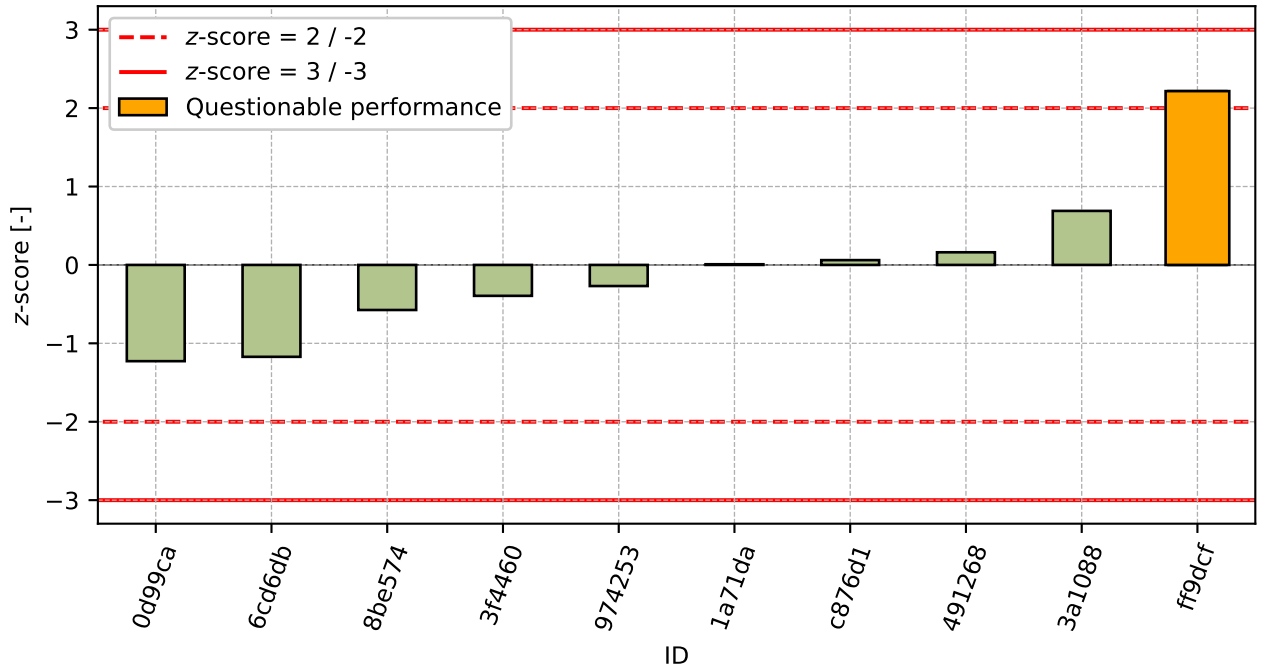

Figure 47: z-score

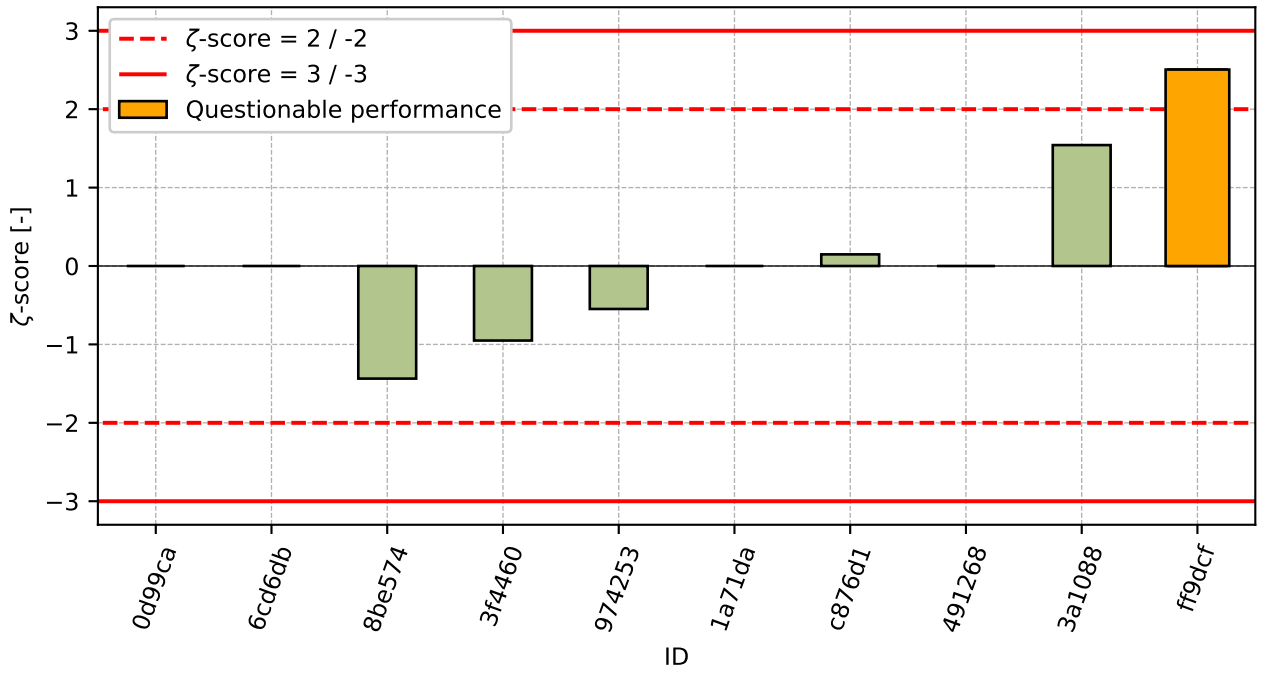

Figure 48: ζ-score

Table 18: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
0d99ca	-1.23	-
6cd6db	-1.17	-
8be574	-0.57	-1.44
3f4460	-0.39	-0.95
974253	-0.27	-0.55
1a71da	0.01	-
c876d1	0.06	0.15
491268	0.16	-
3a1088	0.69	1.54
ff9dcf	2.22	2.51

1.6 Compressive Strength after 28 days of ageing

1.6.1 Test results

Table 19: 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 [%]
8be574	47.0	47.4	47.2	47.1	47.3	47.2	0.8	47.2	0.14	0.3
f38b13	53.3	53.9	53.4	55.5	53.8	50.4	1.5	53.4	1.66	3.12
1a71da	54.0	52.6	53.7	52.3	54.3	54.4	-	53.6	0.89	1.67
ff9dcf	53.8	53.8	55.0	53.1	53.8	53.1	2.6	53.8	0.69	1.29
3a1088	58.6	58.3	57.7	57.8	56.8	59.0	4.2	58.0	0.78	1.34
974253	60.9	53.6	60.4	58.3	56.2	59.7	3.0	58.2	2.81	4.83
c876d1	59.3	59.9	60.4	59.0	60.4	60.3	0.8	59.9	0.6	1.01
491268	61.5	59.7	62.1	57.5	58.8	61.9	-	60.2	1.88	3.12
6cd6db	62.8	61.1	60.6	62.7	57.5	58.7	-	60.6	2.13	3.52
0d99ca	62.4	61.1	61.4	62.6	60.9	60.1	-	61.4	0.95	1.54
3f4460	65.1	64.3	69.4	68.3	61.7	63.2	3.4	65.3	2.98	4.56

1.6.2 The Numerical Procedure for Determining Outliers

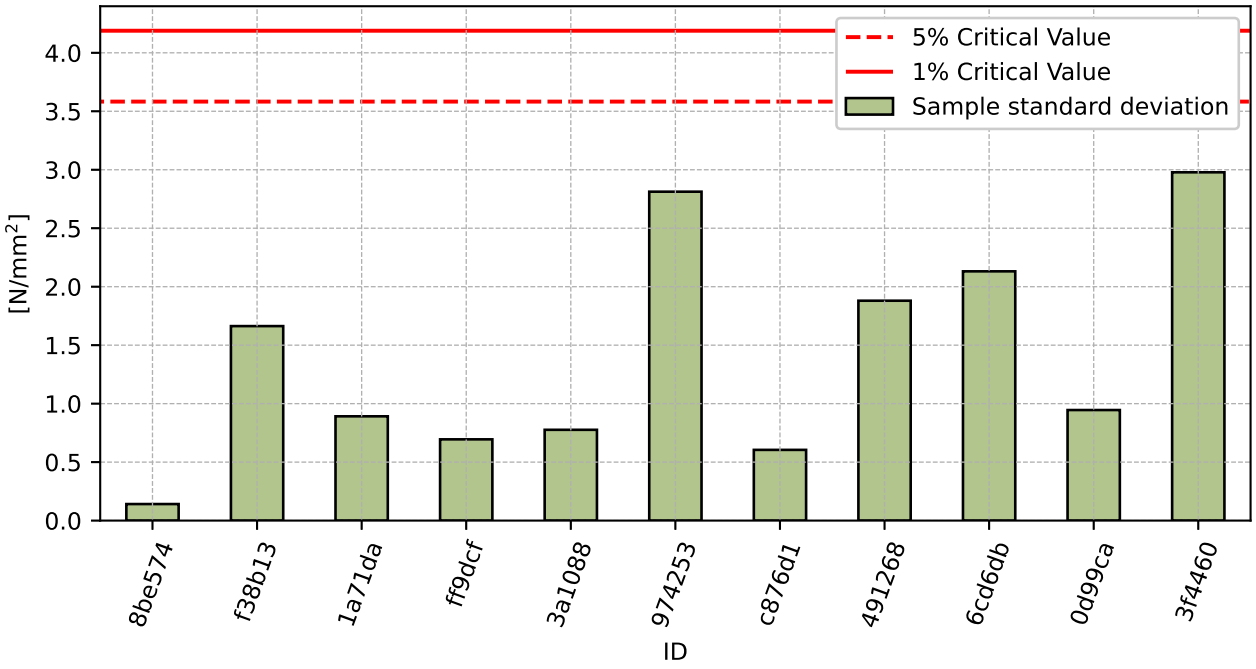

Figure 49: **Cochran's test** - sample standard deviations

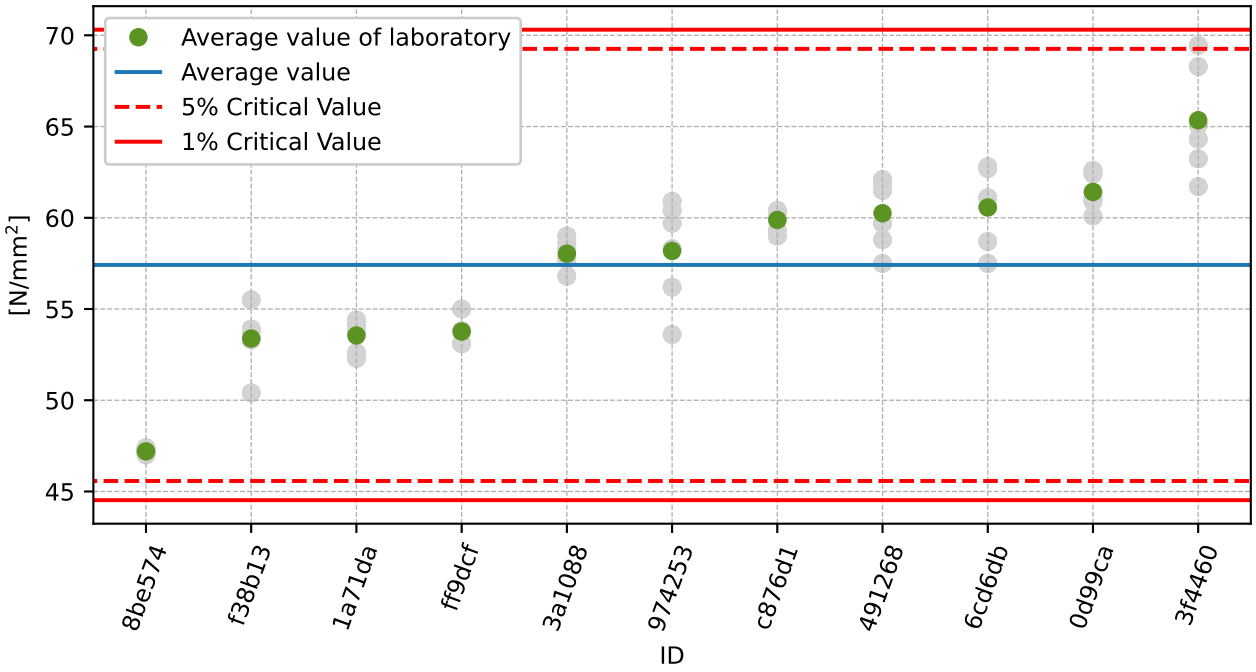

Figure 50: **Grubbs' test** - average values

1.6.3 Mandel's Statistics

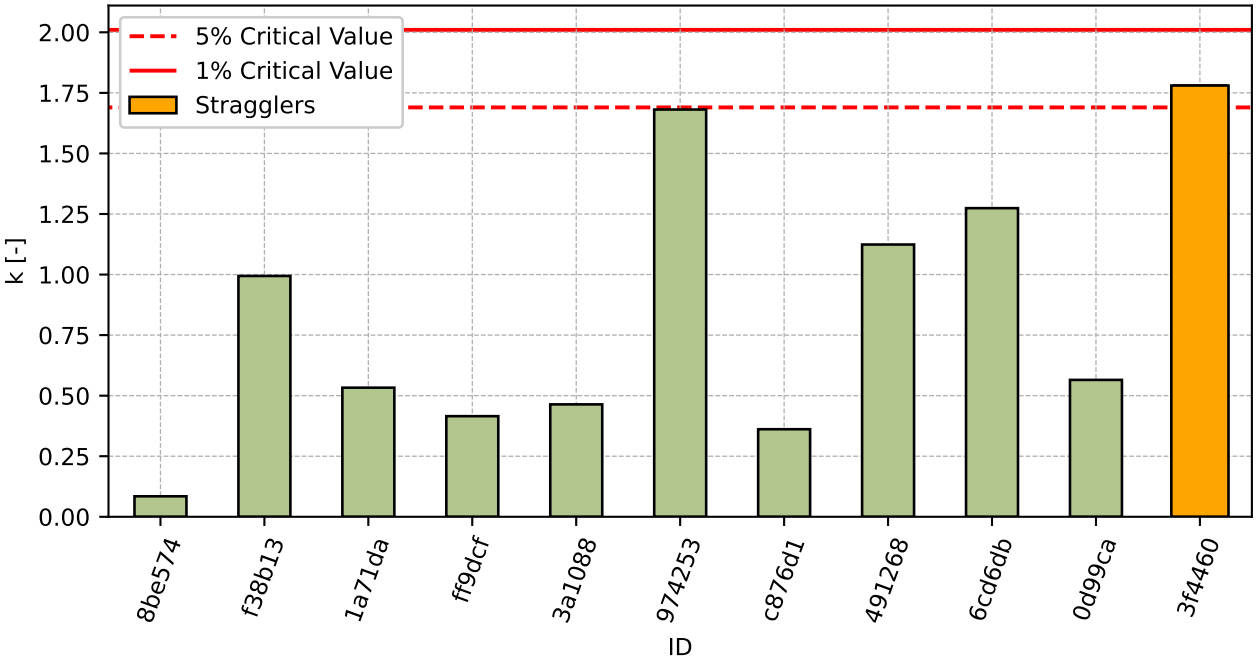

Figure 51: Intralaboratory Consistency Statistic

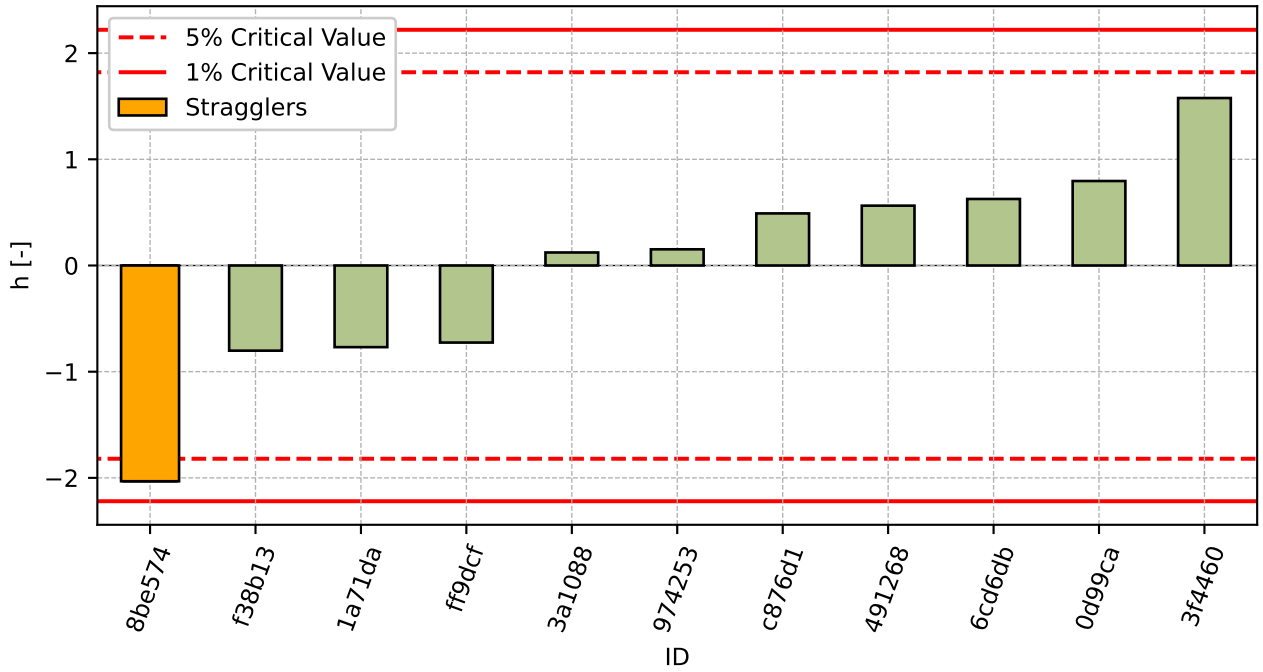

Figure 52: Interlaboratory Consistency Statistic

1.6.4 Descriptive statistics

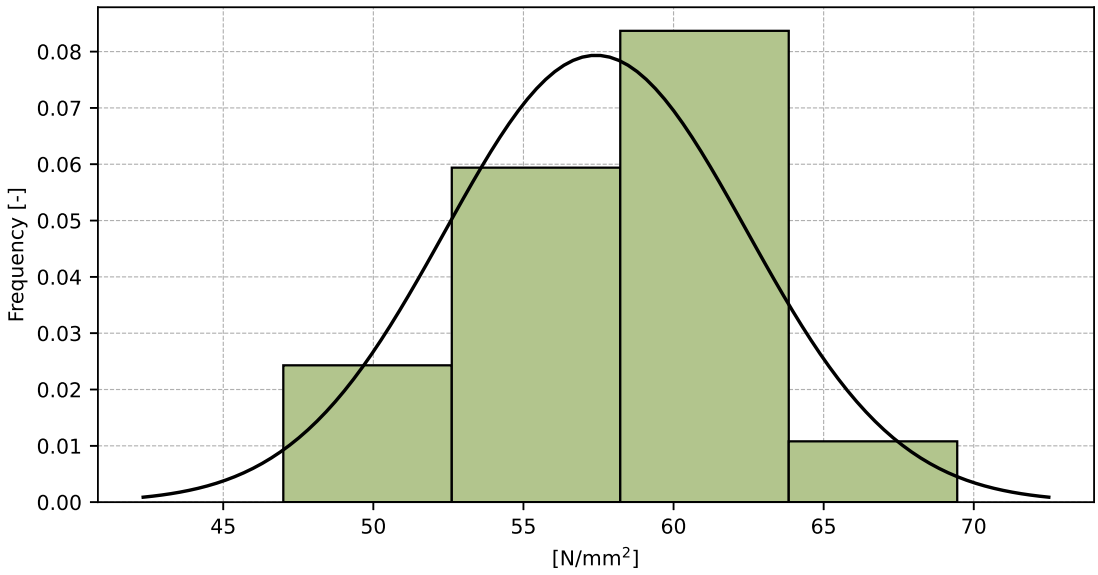

Figure 53: Histogram of all test results

Table 20: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	57.4
Sample standard deviation – s	5.03
Asigned value – x^*	57.8
Robust standard deviation – s^*	4.69
Measurement uncertainty of asigned value – u_X	1.77
p-value of normality test	0.601 [-]
Interlaboratory standard deviation – s_L	4.98
Repeatability standard deviation – s_r	1.67
Reproducibility standard deviation – s_R	5.25
Repeatability – r	4.7
Reproducibility – R	14.7

1.6.5 Evaluation of Performance Statistics

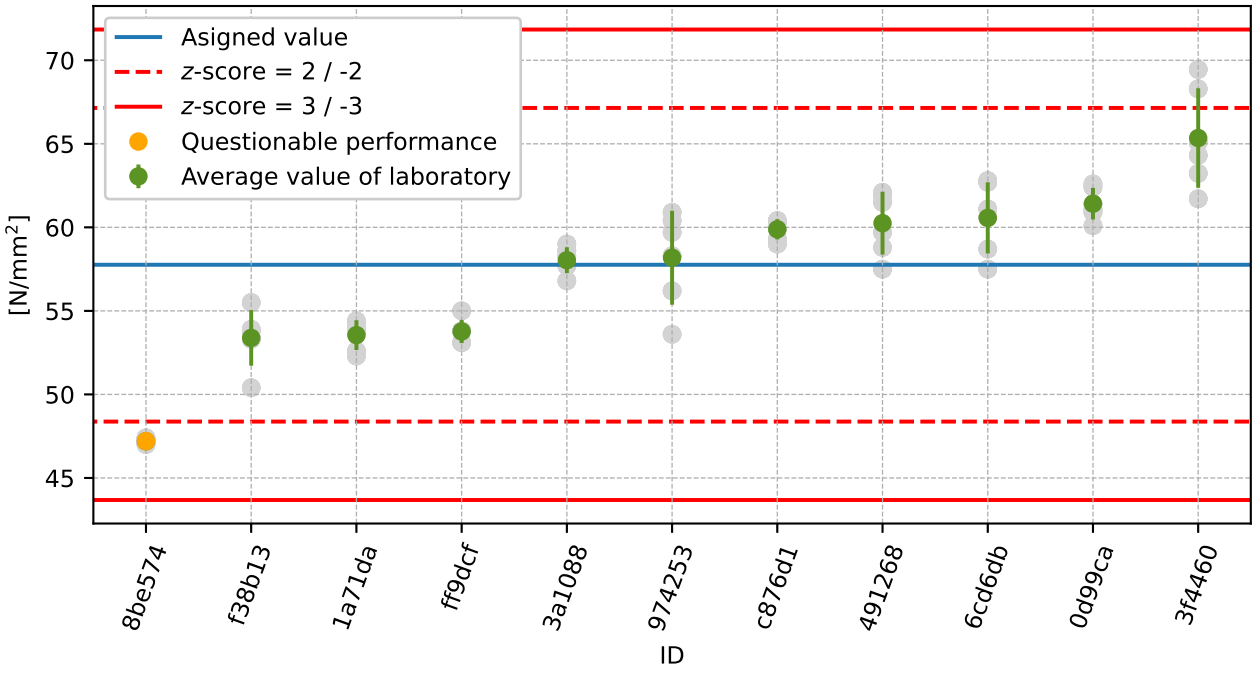

Figure 54: Average values and sample standard deviations

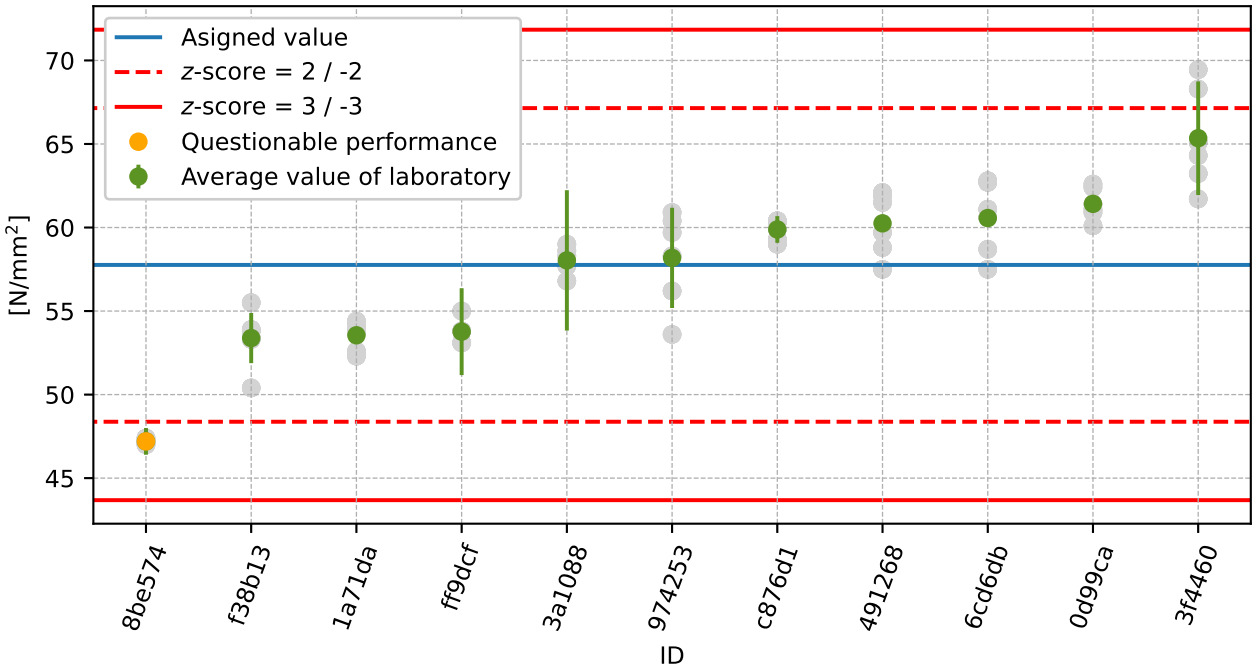

Figure 55: Average values and extended uncertainties of measurement

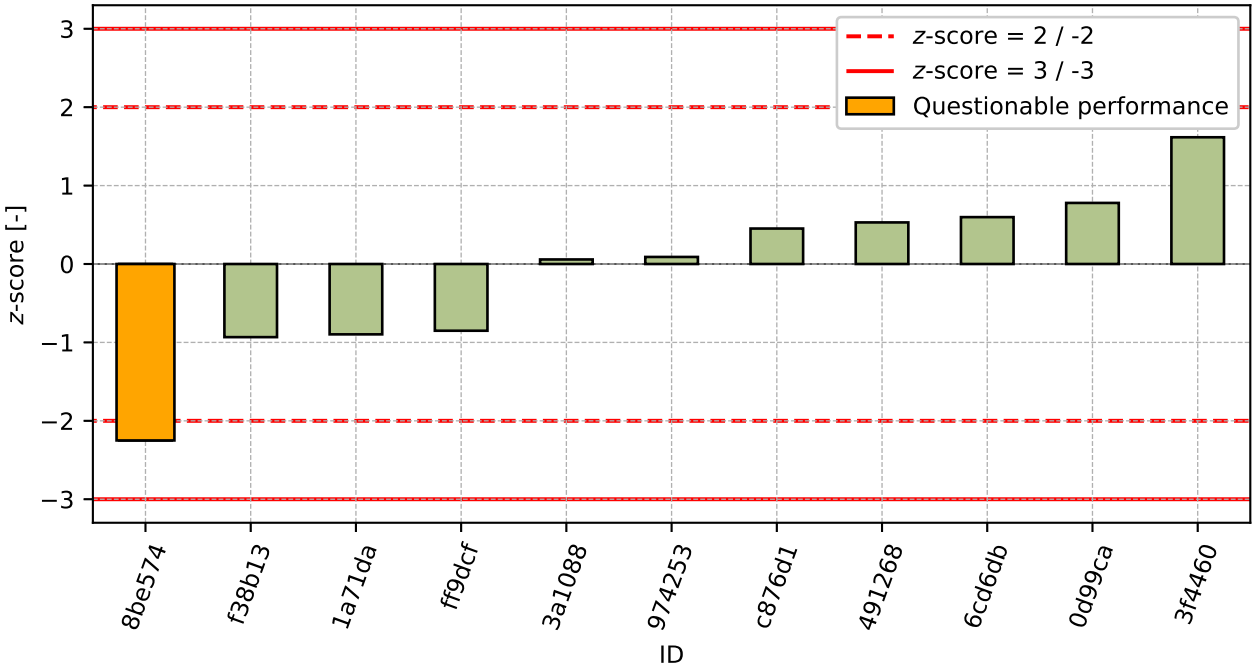

Figure 56: z-score

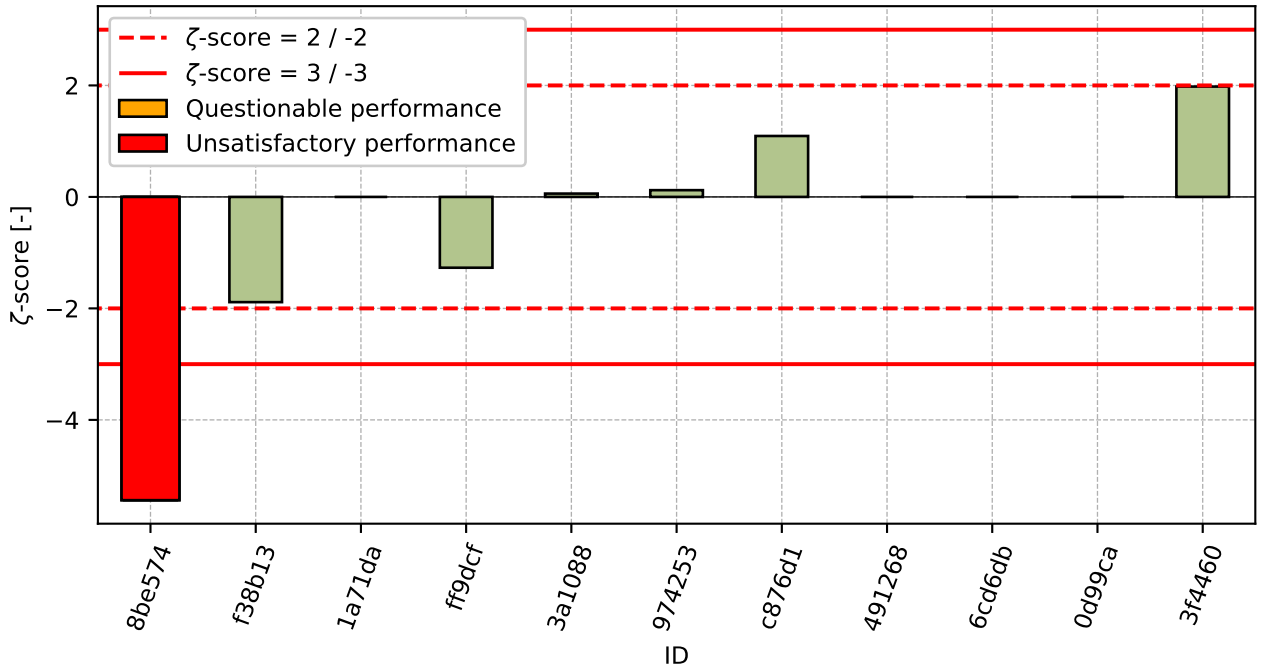

Figure 57: ζ-score

Table 21: *z*-score and ζ-score

ID	*z*-score [-]	ζ-score [-]
8be574	-2.25	-5.44
f38b13	-0.93	-1.89
1a71da	-0.9	-
ff9dcf	-0.85	-1.27
3a1088	0.06	0.06
974253	0.09	0.12
c876d1	0.45	1.09
491268	0.53	-
6cd6db	0.6	-
0d99ca	0.78	-
3f4460	1.62	1.98

2 Appendix – EN 196-2 (art. 4.4.1) – Determination of loss on ignition

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

3 Appendix – EN 196-2 (art. 4.4.2) – Determination of sulphate content

3.1 Test results

Table 22: 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 [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
1a71da	1.82	1.84	1.86	-	1.84	0.02	1.09
a0e7ed	2.94	2.94	2.98	0.05	2.95	0.023	0.78
37d0bb	3.02	3.03	3.03	0.11	3.03	0.006	0.19
323f82	3.03	3.05	3.02	0.02	3.03	0.015	0.5

3.2 The Numerical Procedure for Determining Outliers

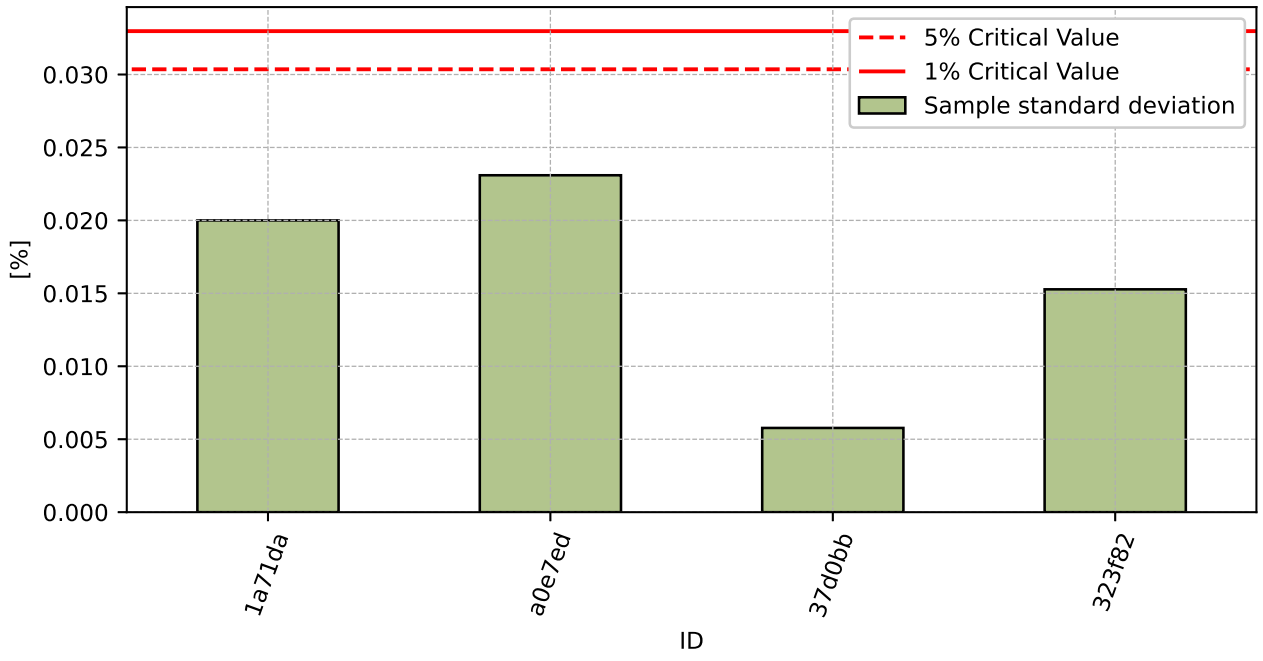

Figure 58: **Cochran's test** - sample standard deviations

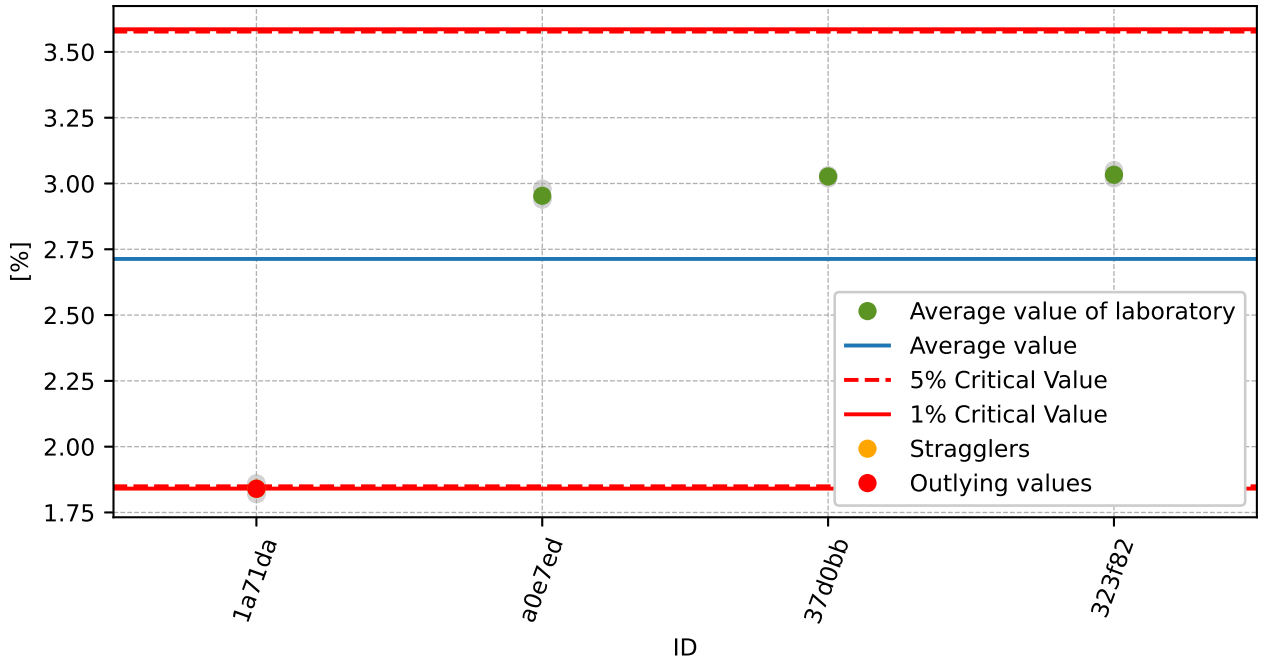

Figure 59: **Grubbs' test** - average values

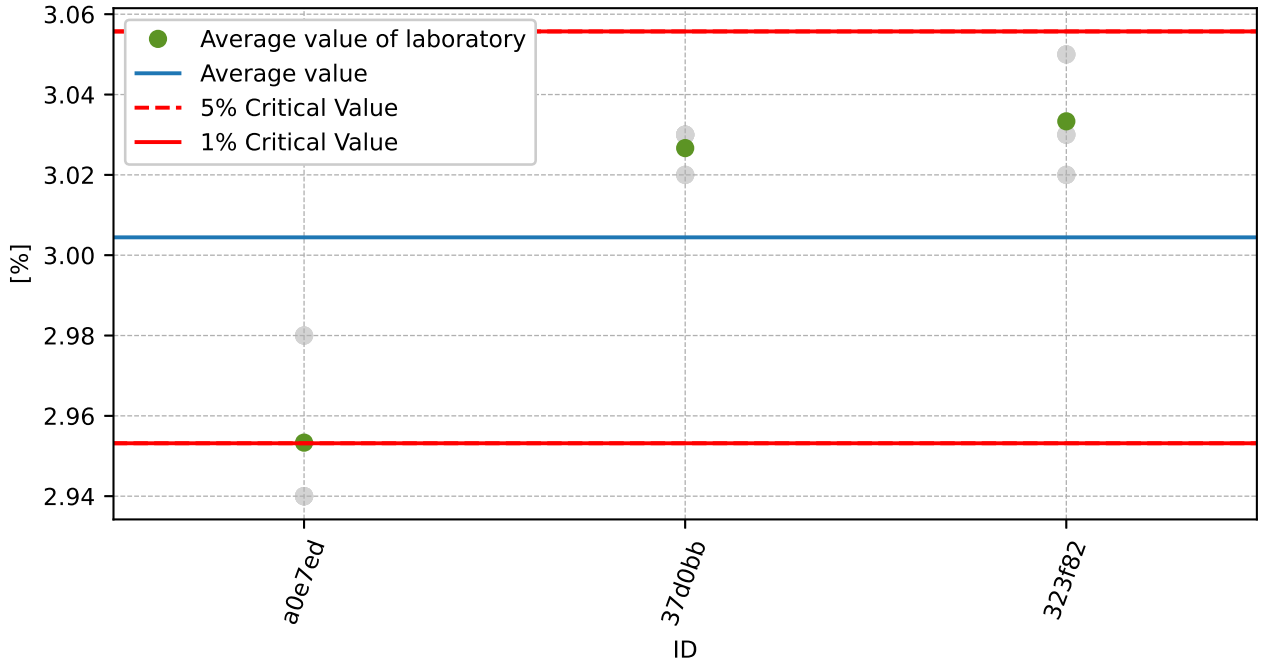

Figure 60: **Grubbs' test** - average values without outliers

3.3 Mandel's Statistics

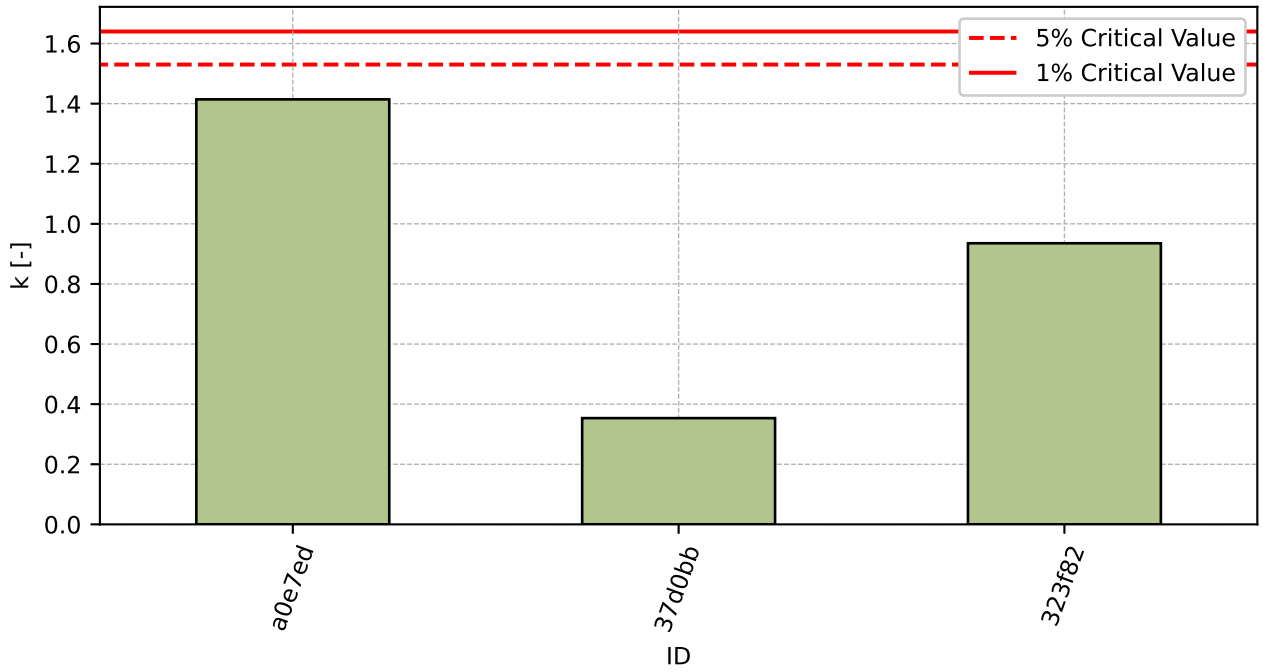

Figure 61: Intralaboratory Consistency Statistic

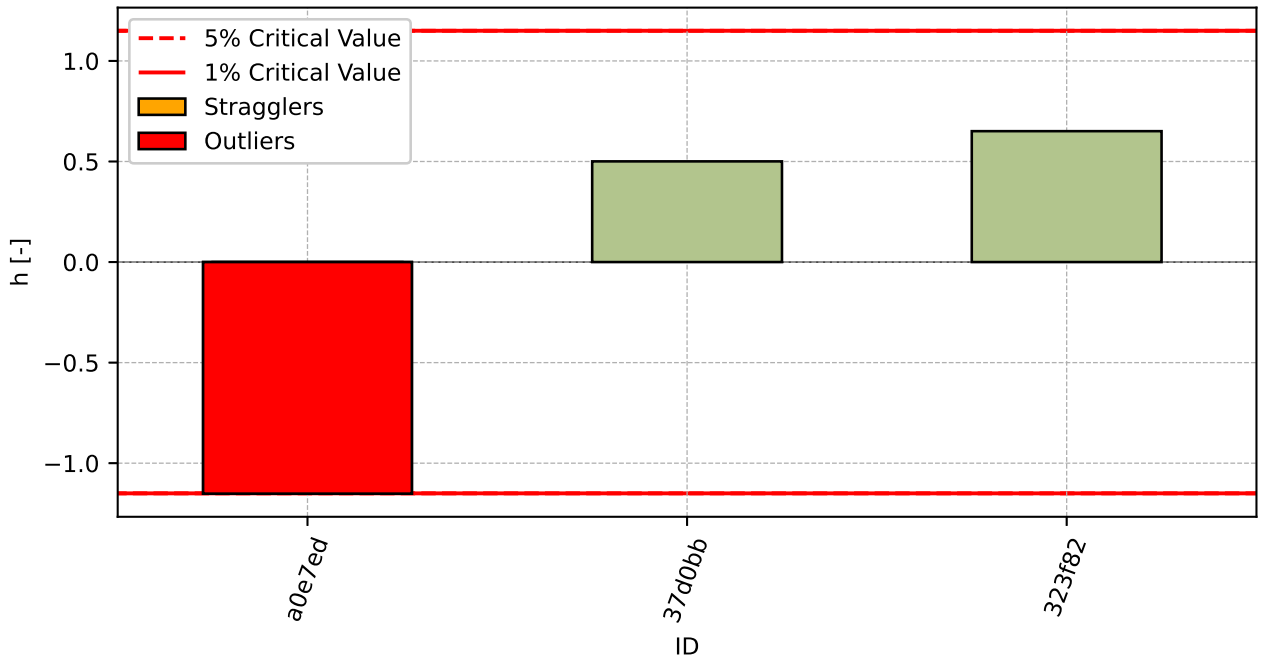

Figure 62: Interlaboratory Consistency Statistic

3.4 Descriptive statistics

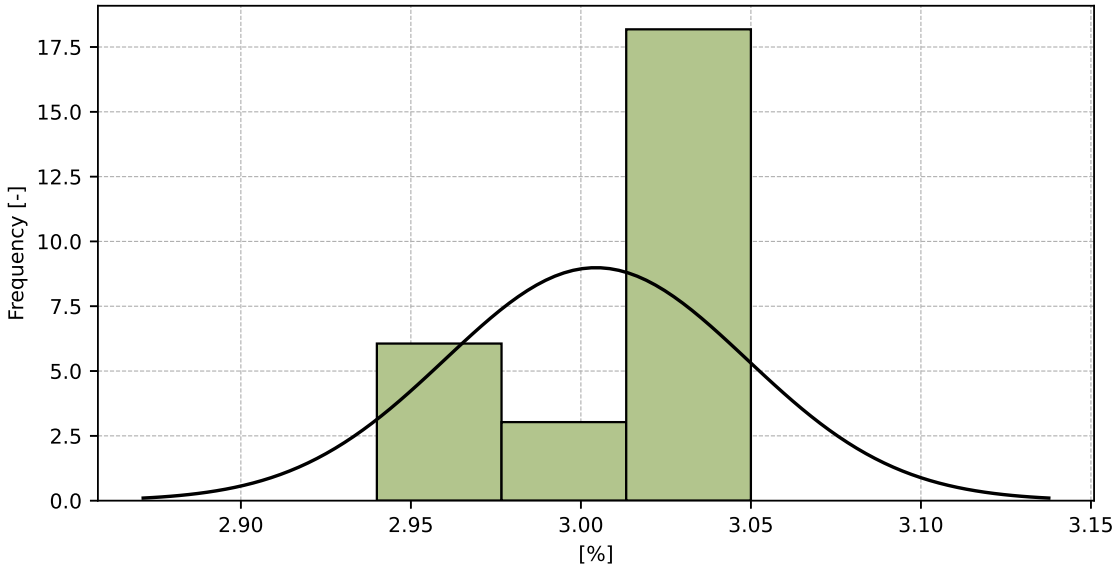

Figure 63: Histogram of all test results

Table 23: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	3.0
Sample standard deviation – s	0.044
Asigned value – x^*	3.0
Robust standard deviation – s^*	0.044
Measurement uncertainty of asigned value – u_X	0.026
p-value of normality test	0.388 [-]
Interlaboratory standard deviation – s_L	0.043
Repeatability standard deviation – s_r	0.016
Reproducibility standard deviation – s_R	0.046
Repeatability – r	0.05
Reproducibility – R	0.13

3.5 Evaluation of Performance Statistics

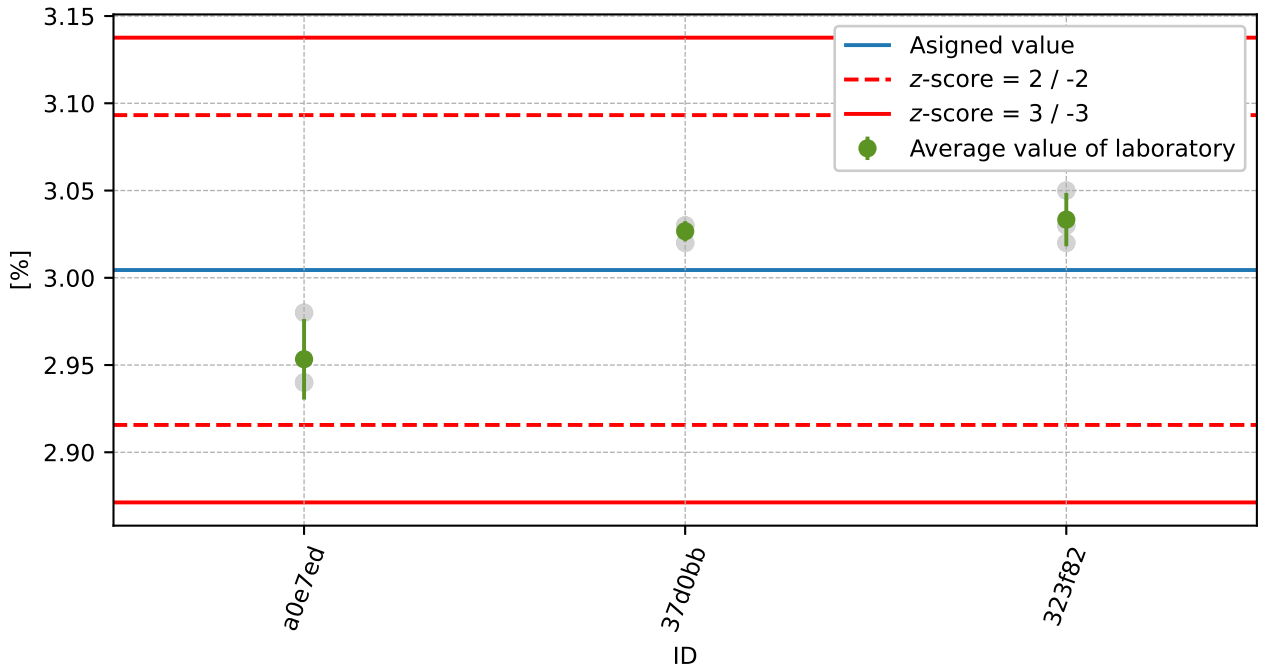

Figure 64: Average values and sample standard deviations

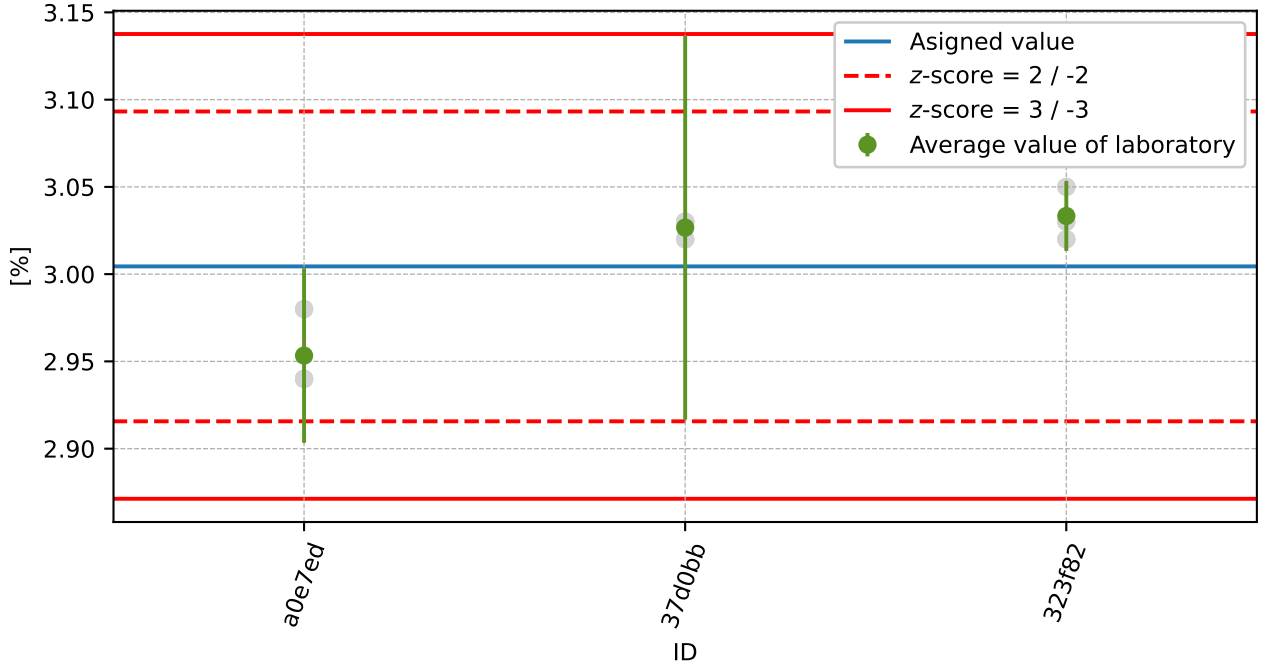

Figure 65: Average values and extended uncertainties of measurement

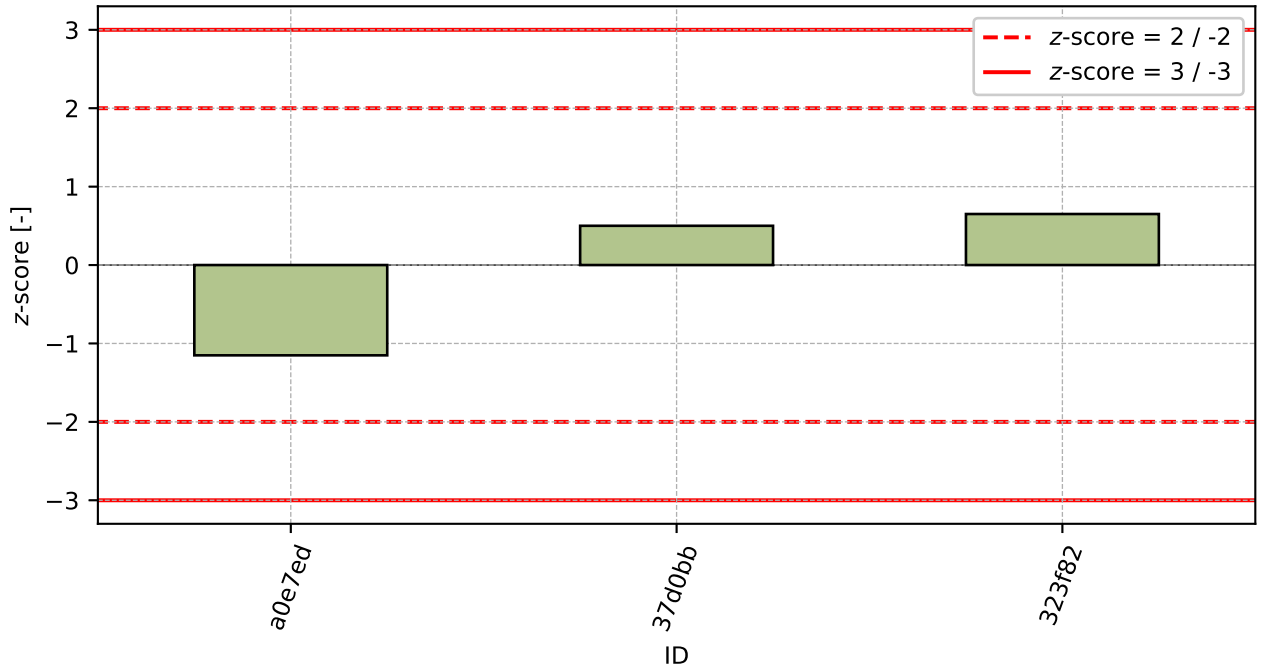

Figure 66: z-score

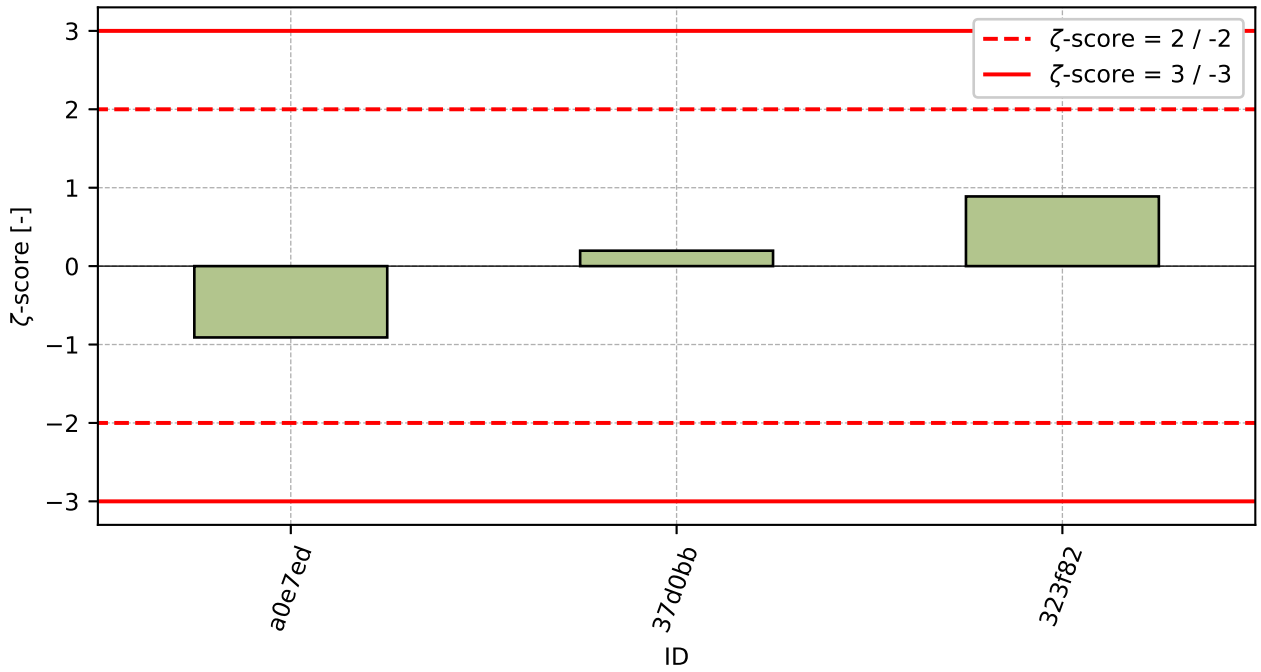

Figure 67: ζ-score

Table 24: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a0e7ed	-1.15	-0.91
37d0bb	0.5	0.2
323f82	0.65	0.89

4 Appendix – EN 196-2 (art. 4.4.3) – Determination of the residue insoluble in hydrochloric acid and sodium carbonate

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

5 Appendix – EN 196-2 (art. 4.4.4) – Determination of the residue insoluble in hydrochloric acid and potassium hydroxide

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

6 Appendix – EN 196-2 (art. 4.4.5) – Determination of sulphite content

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

7 Appendix – EN 196-2 (art. 4.4.6) – Determination of manganese content

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

8 Appendix – EN 196-3 – Setting time, Soundness

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

9 Appendix – EN 196-10 – Determination of the water-soluble chromium (Cr^{6+})

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

10 Appendix – EN 1015-1 – Granularity

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

11 Appendix – EN 1015-3 – Consistency

11.1 Test results

Table 25: 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 [mm]			u_X [mm]	$\bar{x}$ [mm]	s_0 [mm]	V_X [%]
cb2337	170	170	165	0	168	2.9	1.71
a12b46	185	188	184	0	186	2.1	1.12
1a71da	193	196	194	-	194	1.5	0.79
972154	202	202	203	2	202	0.6	0.29
736c97	215	205	202	-	208	6.6	3.19
491268	209	208	208	2	208	0.7	0.34
781562	222	220	220	5	221	1.2	0.52

11.2 The Numerical Procedure for Determining Outliers

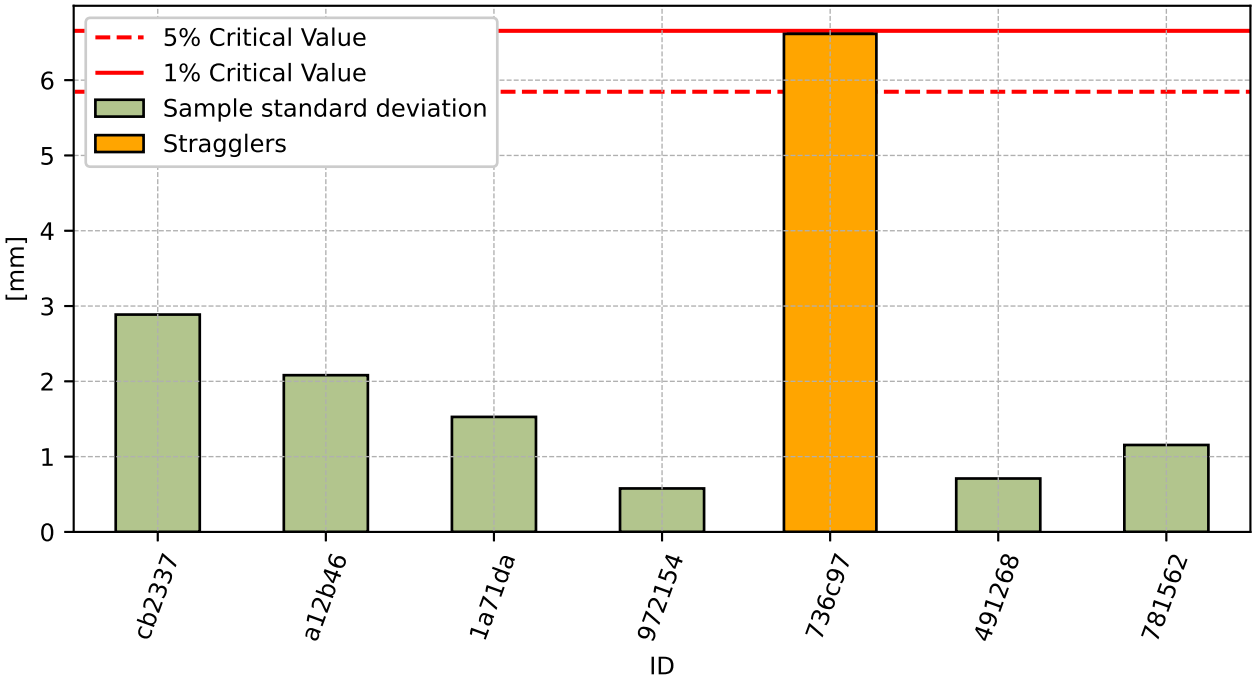

Figure 68: **Cochran's test** - sample standard deviations

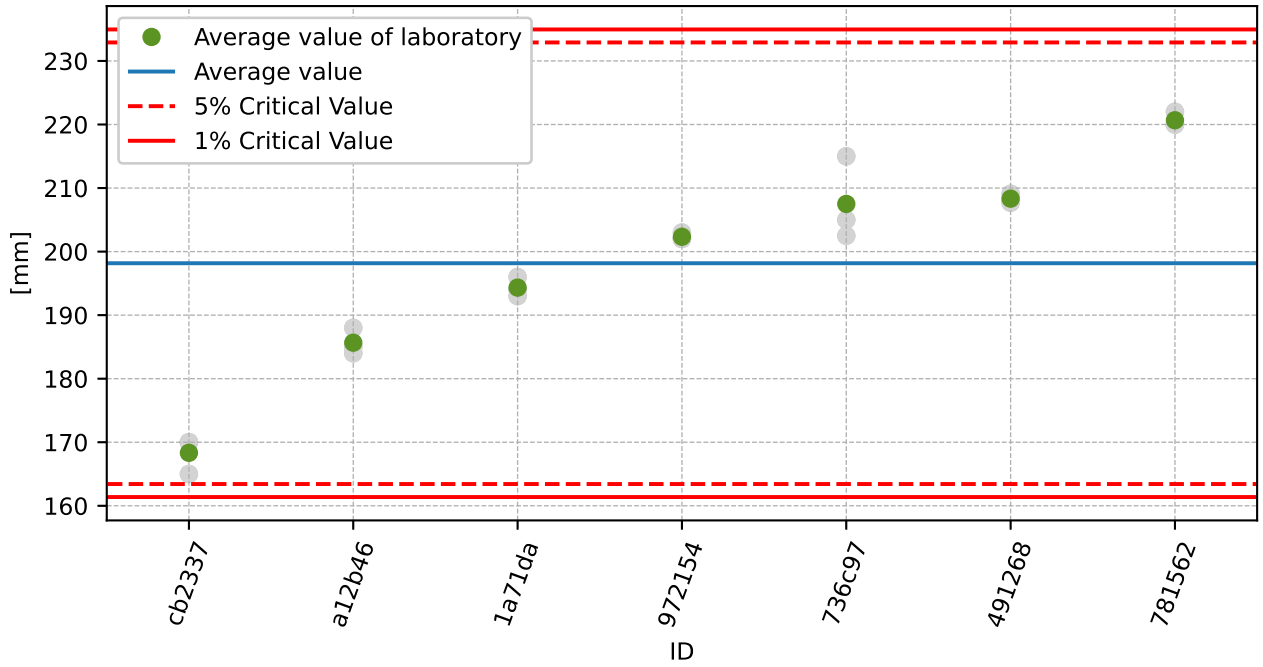

Figure 69: **Grubbs' test** - average values

11.3 Mandel's Statistics

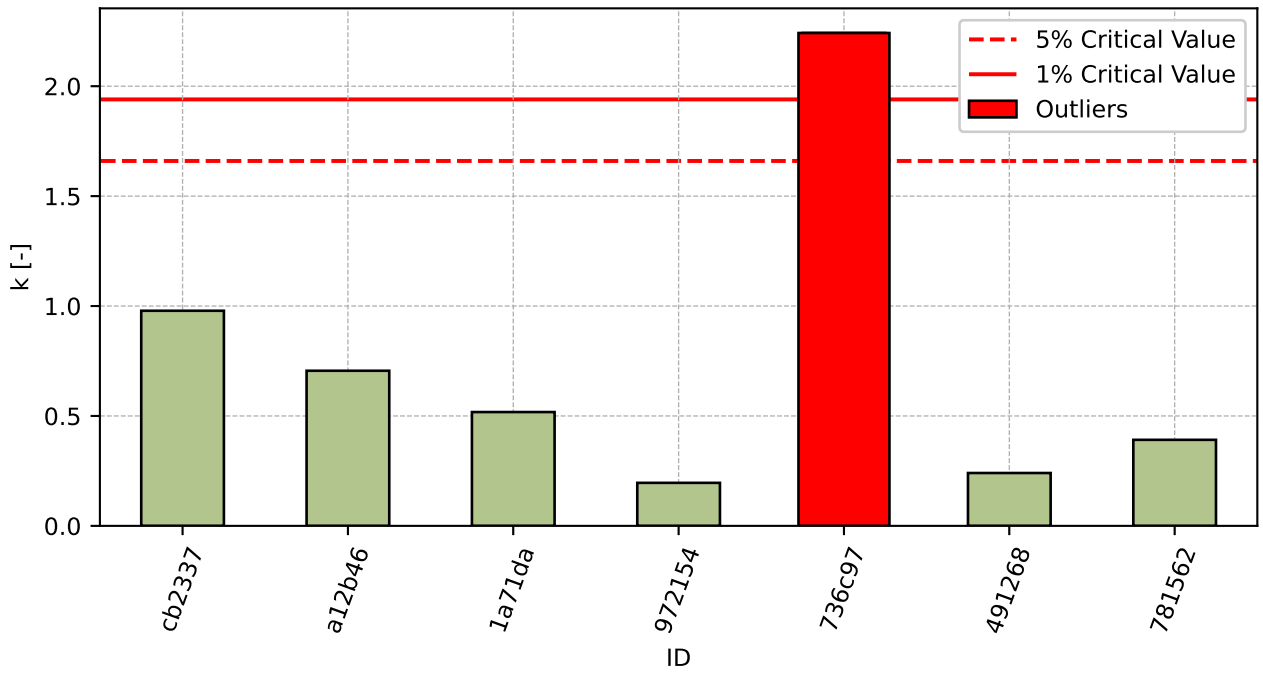

Figure 70: Intralaboratory Consistency Statistic

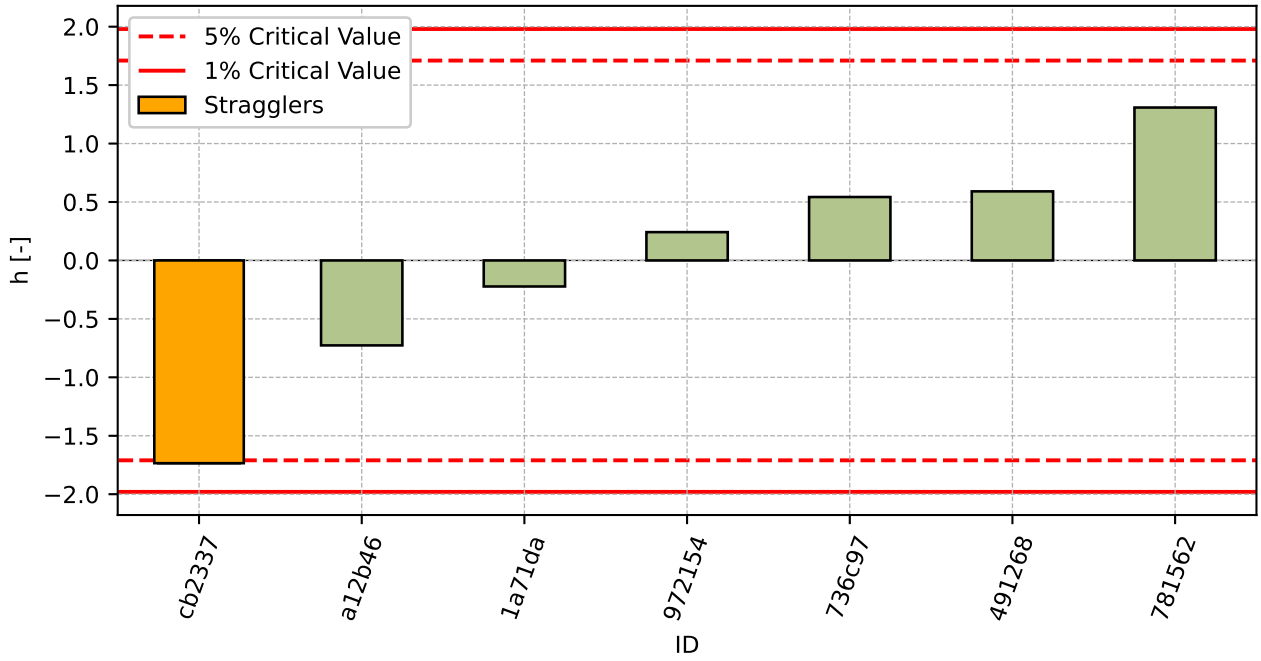

Figure 71: Interlaboratory Consistency Statistic

11.4 Descriptive statistics

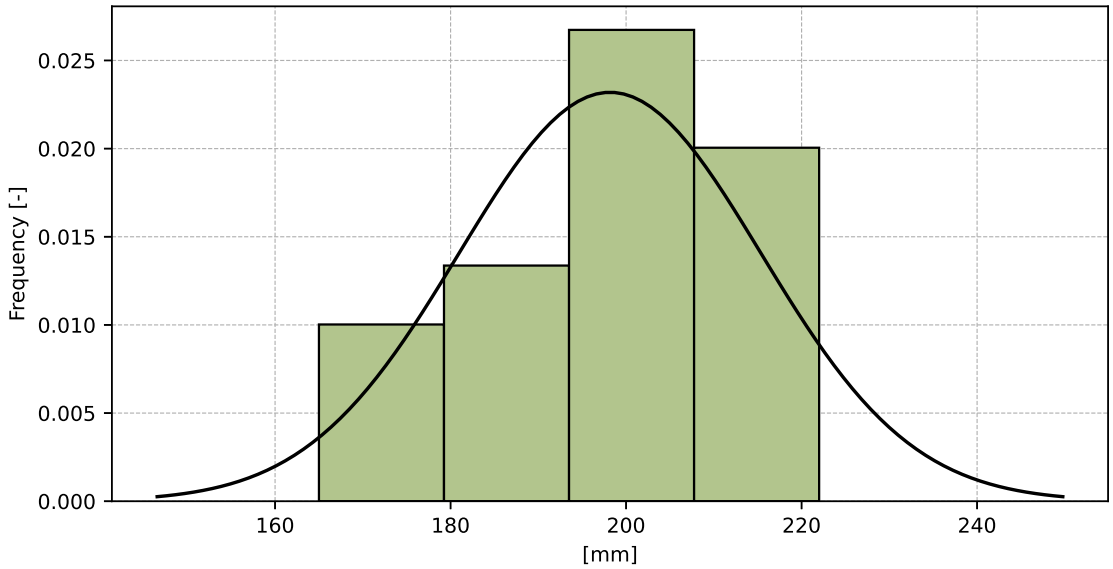

Figure 72: Histogram of all test results

Table 26: Descriptive statistics

Characteristics	[mm]
Average value – $\bar{x}$	198
Sample standard deviation – s	17.2
Asigned value – x^*	200
Robust standard deviation – s^*	13.8
Measurement uncertainty of asigned value – u_X	6.5
p-value of normality test	0.512 [-]
Interlaboratory standard deviation – s_L	17.1
Repeatability standard deviation – s_r	3.0
Reproducibility standard deviation – s_R	17.4
Repeatability – r	8
Reproducibility – R	49

11.5 Evaluation of Performance Statistics

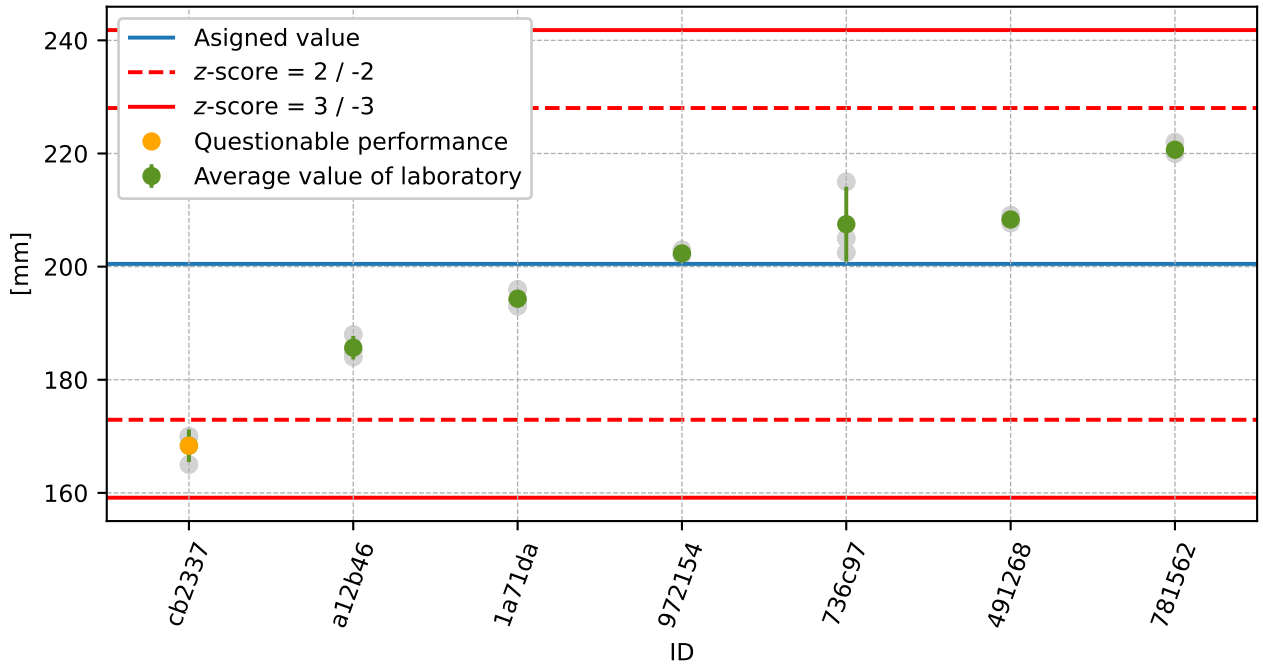

Figure 73: Average values and sample standard deviations

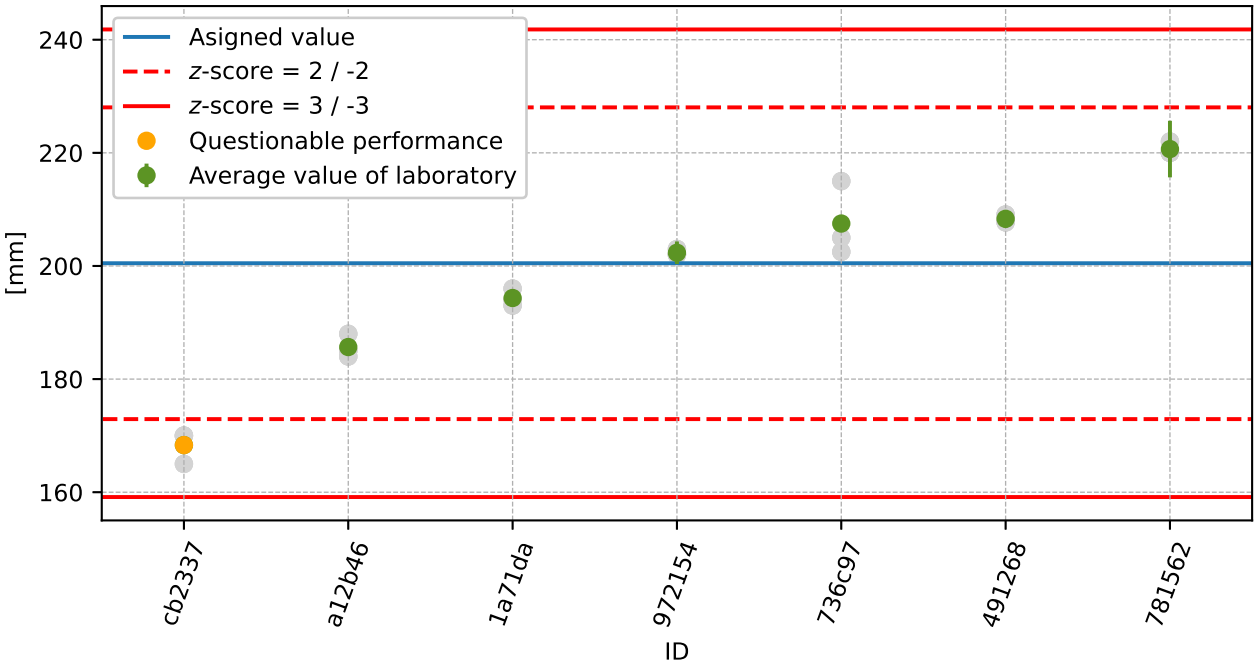

Figure 74: Average values and extended uncertainties of measurement

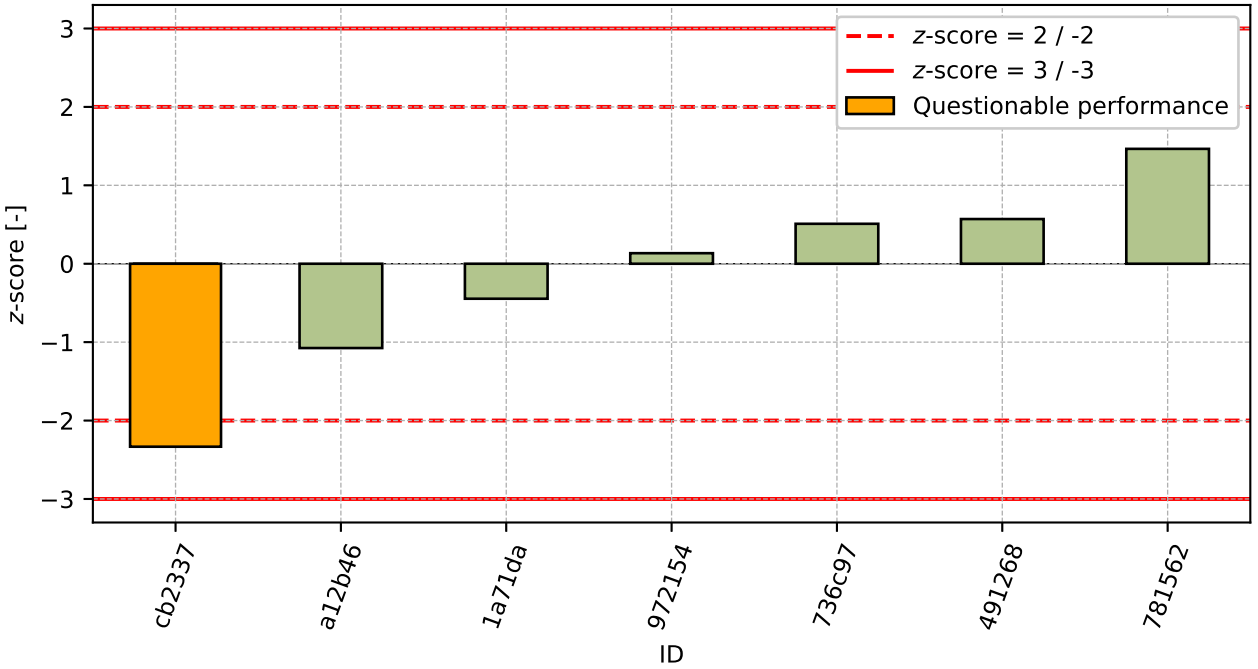

Figure 75: z-score

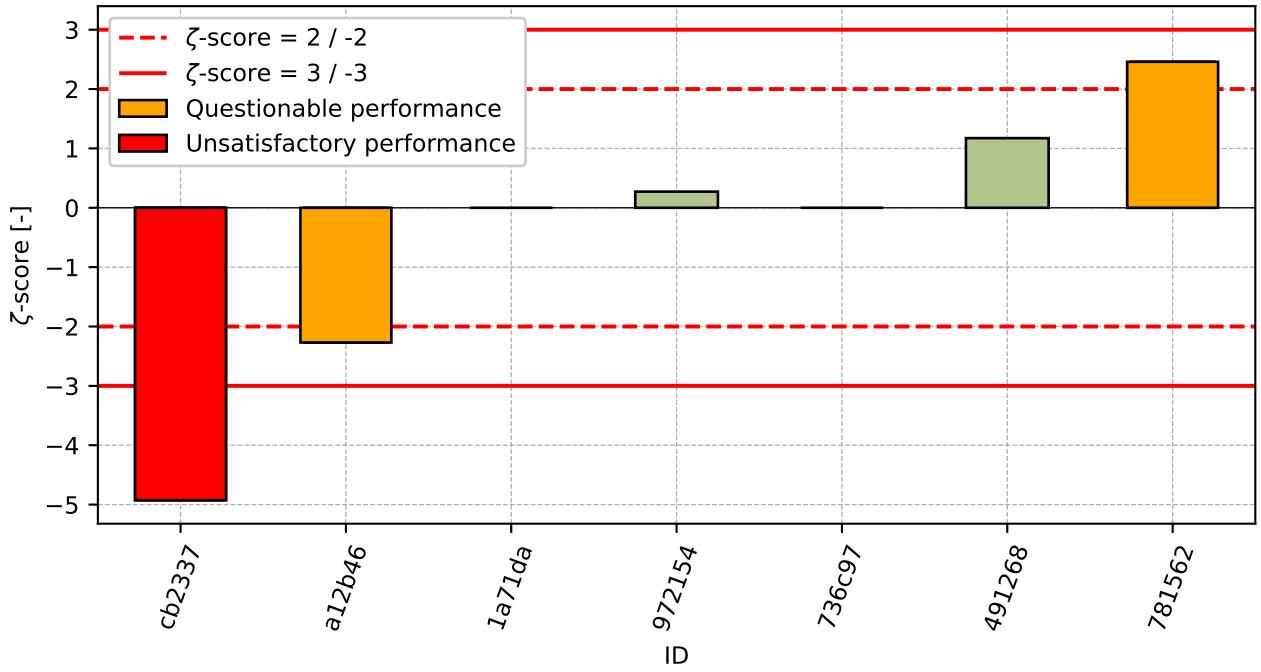

Figure 76: ζ-score

Table 27: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
cb2337	-2.33	-4.93
a12b46	-1.08	-2.27
1a71da	-0.45	-
972154	0.13	0.27
736c97	0.51	-
491268	0.57	1.17
781562	1.47	2.46

12 Appendix – EN 1015-6 – Density of fresh mortar

12.1 Test results

Table 28: 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 [kg/m³]			u_X [kg/m³]	$\bar{x}$ [kg/m³]	s_0 [kg/m³]	V_X [%]
1a71da	2010	2000	2000	-	2003	5.8	0.29
a12b46	2058	2062	2064	10	2061	3.3	0.16
972154	2068	2069	2068	10	2068	0.6	0.03
cb2337	2090	2088	-	-	2089	1.4	0.07
974253	2100	2090	2090	20	2093	5.8	0.28
736c97	2112	2087	2096	-	2098	12.6	0.6
05224d	2130	2120	2120	166	2123	5.8	0.27

12.2 The Numerical Procedure for Determining Outliers

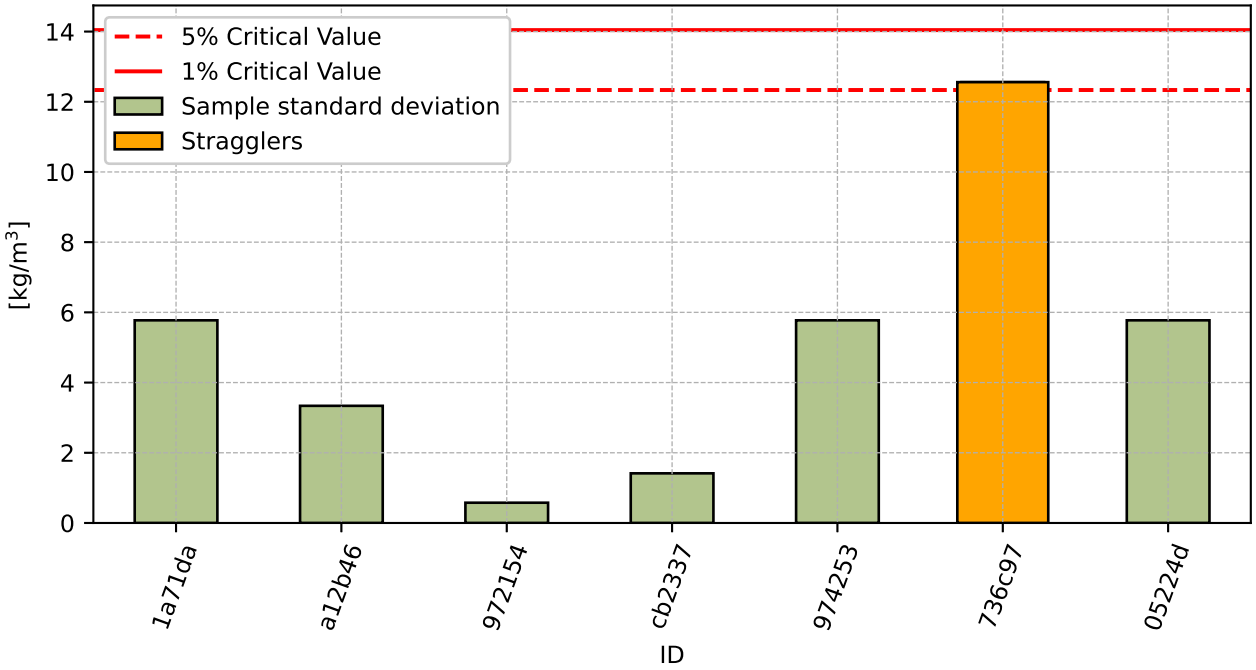

Figure 77: **Cochran's test** - sample standard deviations

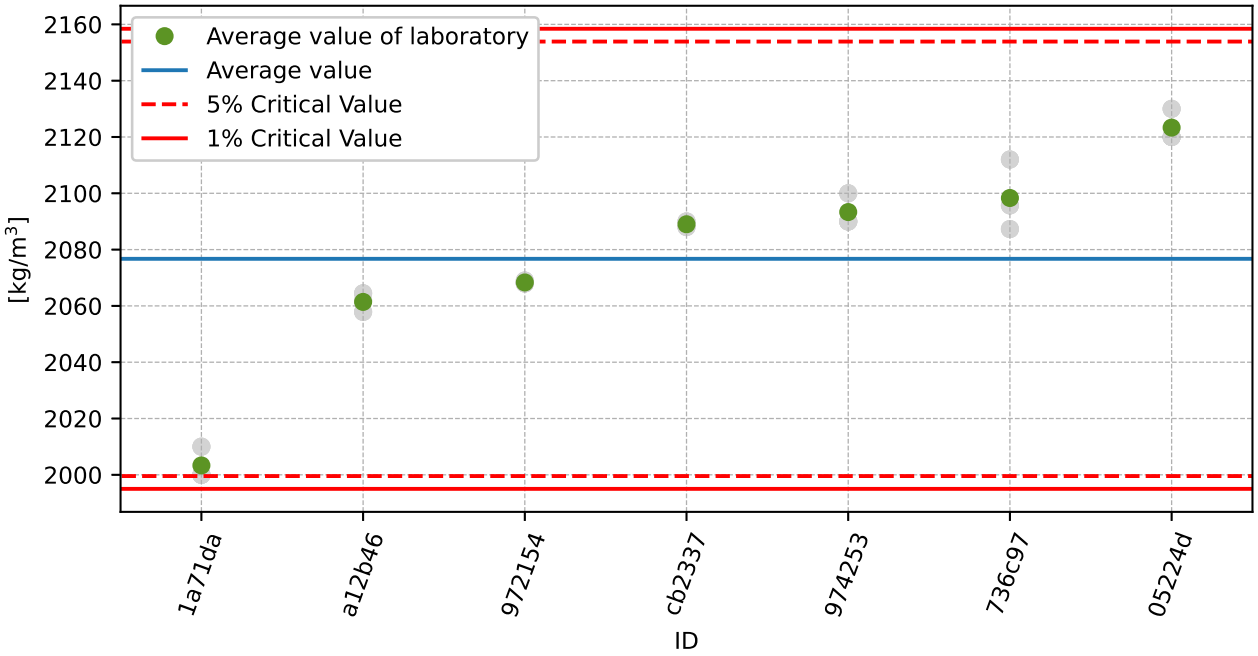

Figure 78: **Grubbs' test** - average values

12.3 Mandel's Statistics

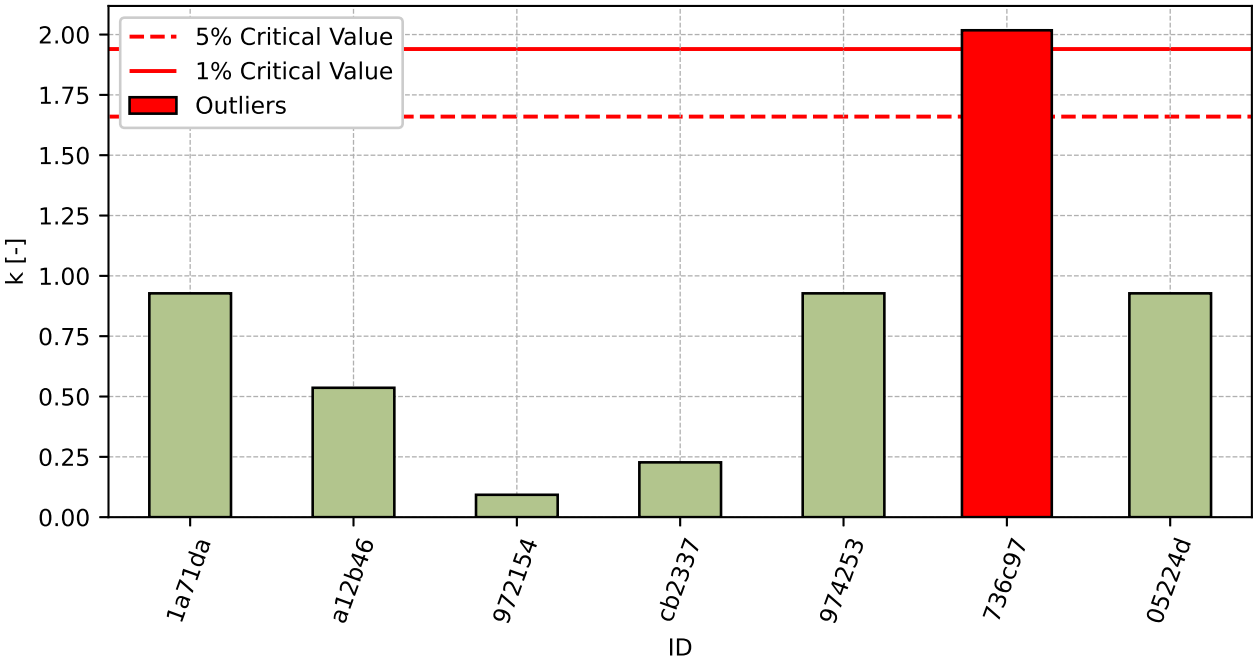

Figure 79: Intralaboratory Consistency Statistic

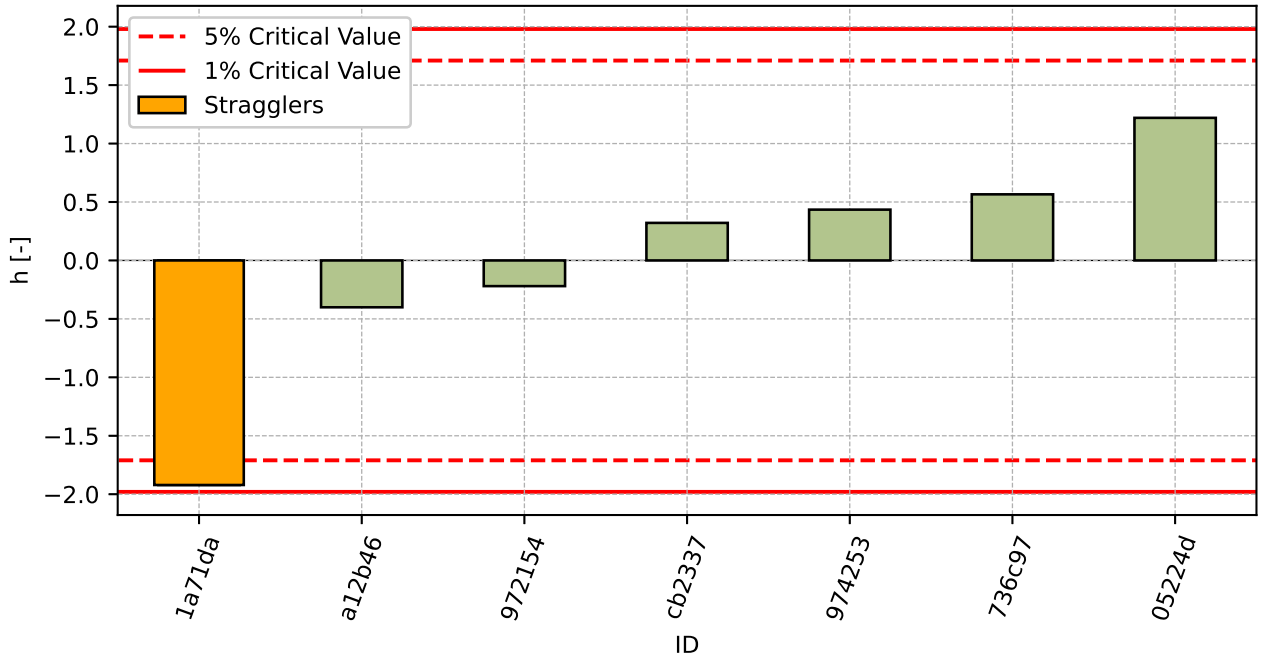

Figure 80: Interlaboratory Consistency Statistic

12.4 Descriptive statistics

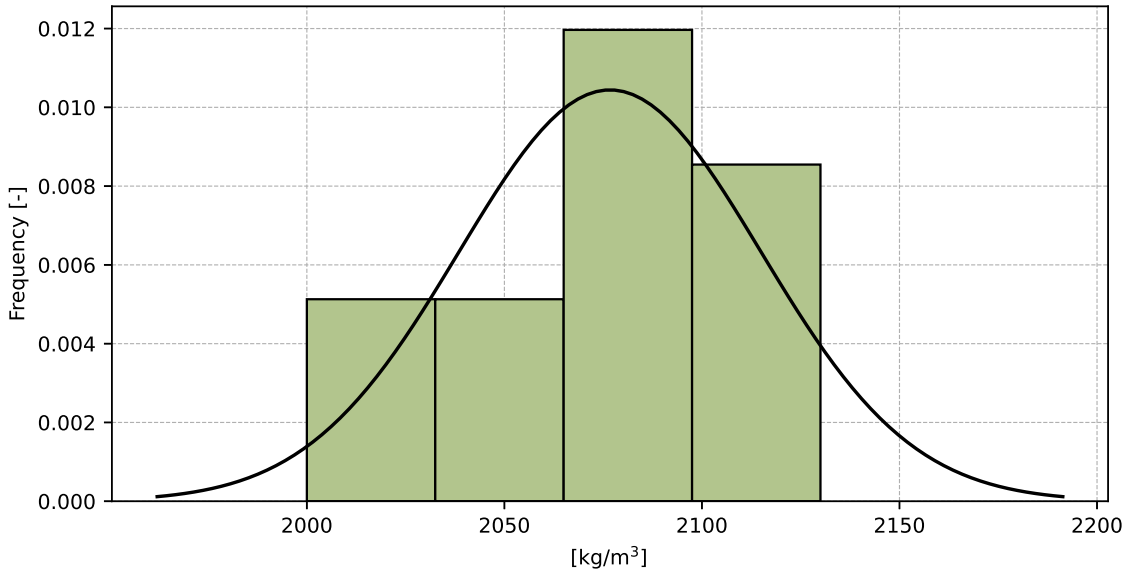

Figure 81: Histogram of all test results

Table 29: Descriptive statistics

Characteristics	[kg/m³]
Average value – $\bar{x}$	2077
Sample standard deviation – s	38.2
Asigned value – x^*	2082
Robust standard deviation – s^*	28.0
Measurement uncertainty of asigned value – u_X	13.2
p-value of normality test	0.377 [-]
Interlaboratory standard deviation – s_L	38.0
Repeatability standard deviation – s_r	6.2
Reproducibility standard deviation – s_R	38.5
Repeatability – r	17
Reproducibility – R	108

12.5 Evaluation of Performance Statistics

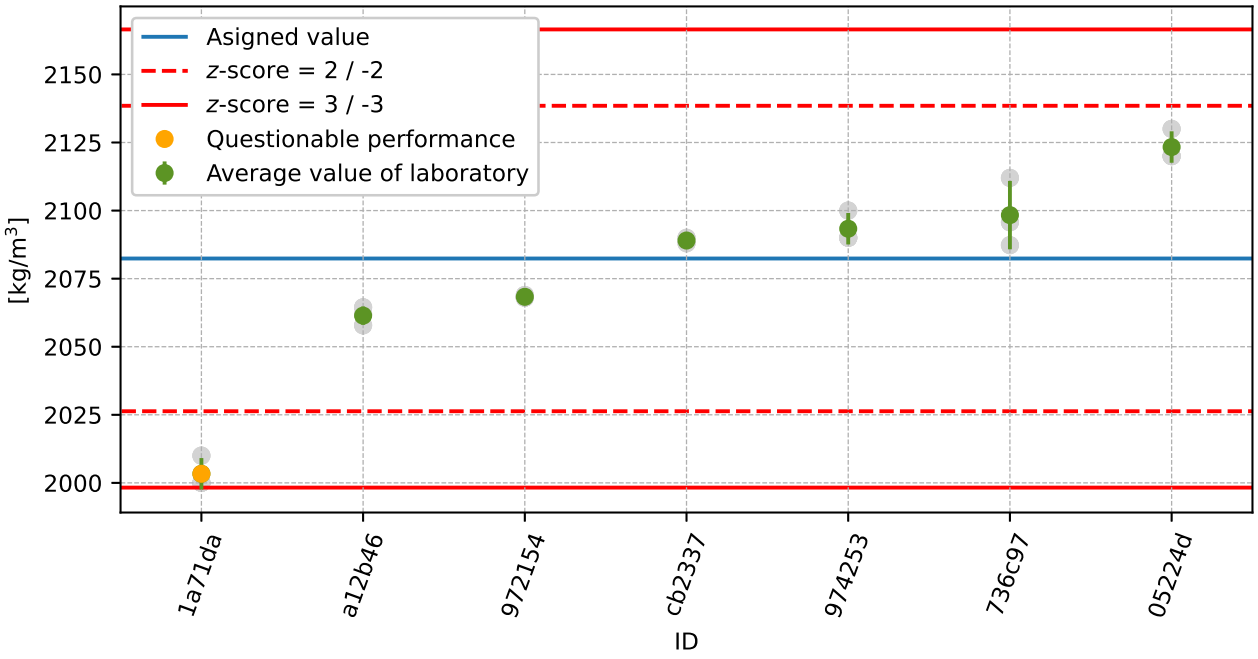

Figure 82: Average values and sample standard deviations

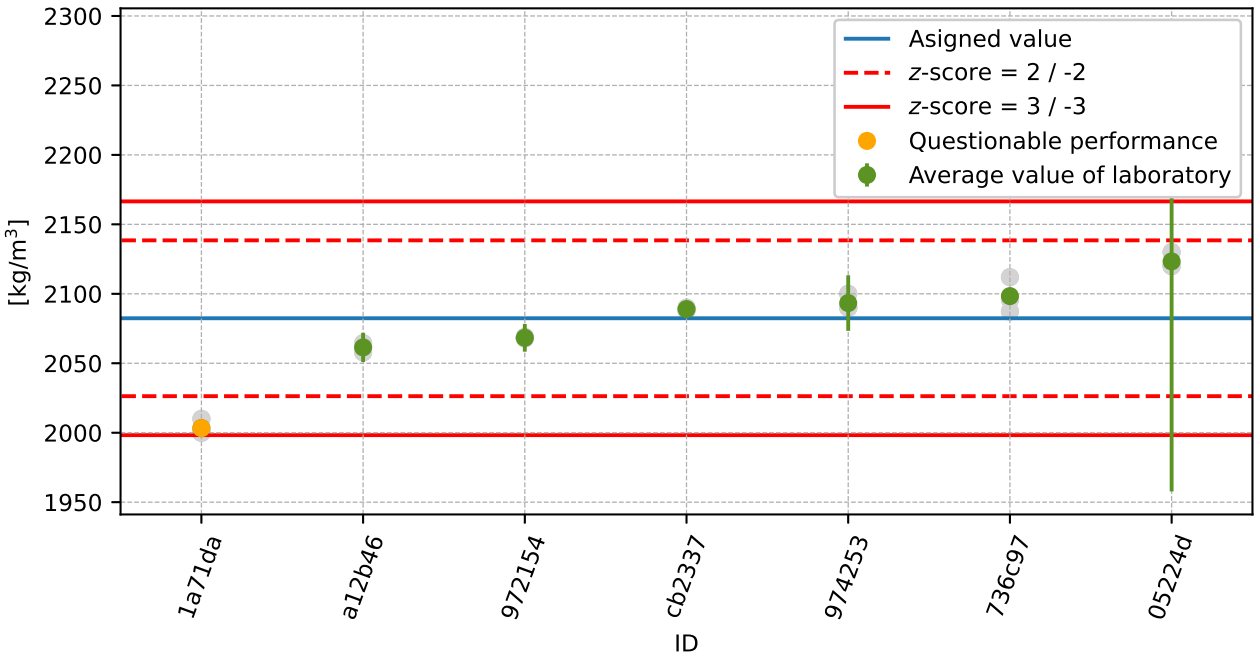

Figure 83: Average values and extended uncertainties of measurement

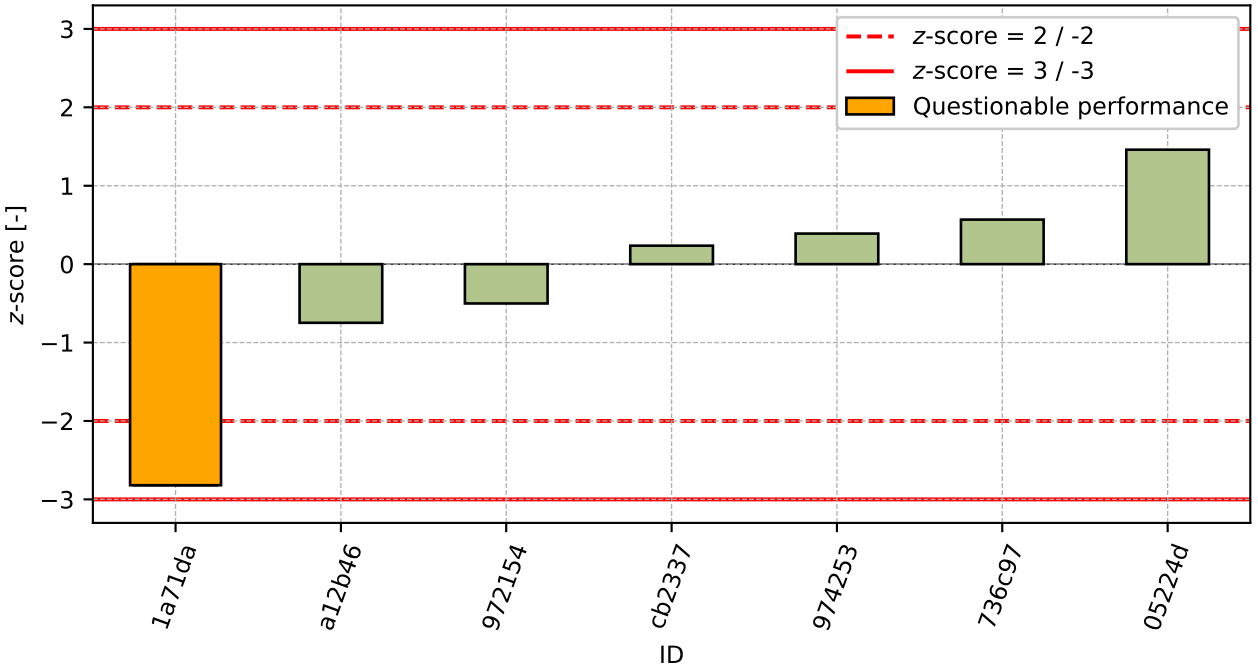

Figure 84: z-score

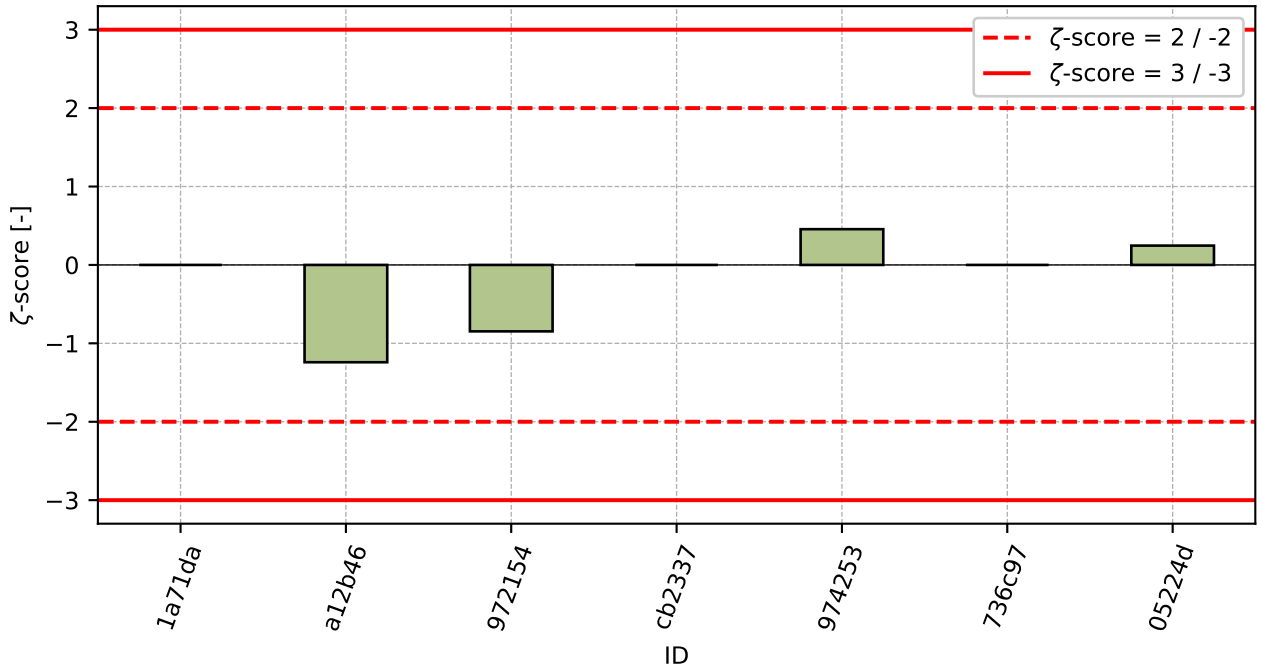

Figure 85: ζ-score

Table 30: *z*-score and ζ-score

ID	*z*-score [-]	ζ-score [-]
1a71da	-2.82	-
a12b46	-0.75	-1.24
972154	-0.5	-0.85
cb2337	0.24	-
974253	0.39	0.46
736c97	0.57	-
05224d	1.46	0.25

13 Appendix – EN 1015-10 – Density of hardened mortar

13.1 Test results

Table 31: 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 [kg/m³]			u_X [kg/m³]	$\bar{x}$ [kg/m³]	s_0 [kg/m³]	V_X [%]
a12b46	1806	1811	1813	12	1810	3.8	0.21
972154	1850	1850	1840	10	1847	5.8	0.31
491268	1890	1870	1880	10	1880	10.0	0.53
974253	1920	1900	1890	20	1903	15.3	0.8
cb2337	2001	2008	-	-	2004	4.9	0.25

13.2 The Numerical Procedure for Determining Outliers

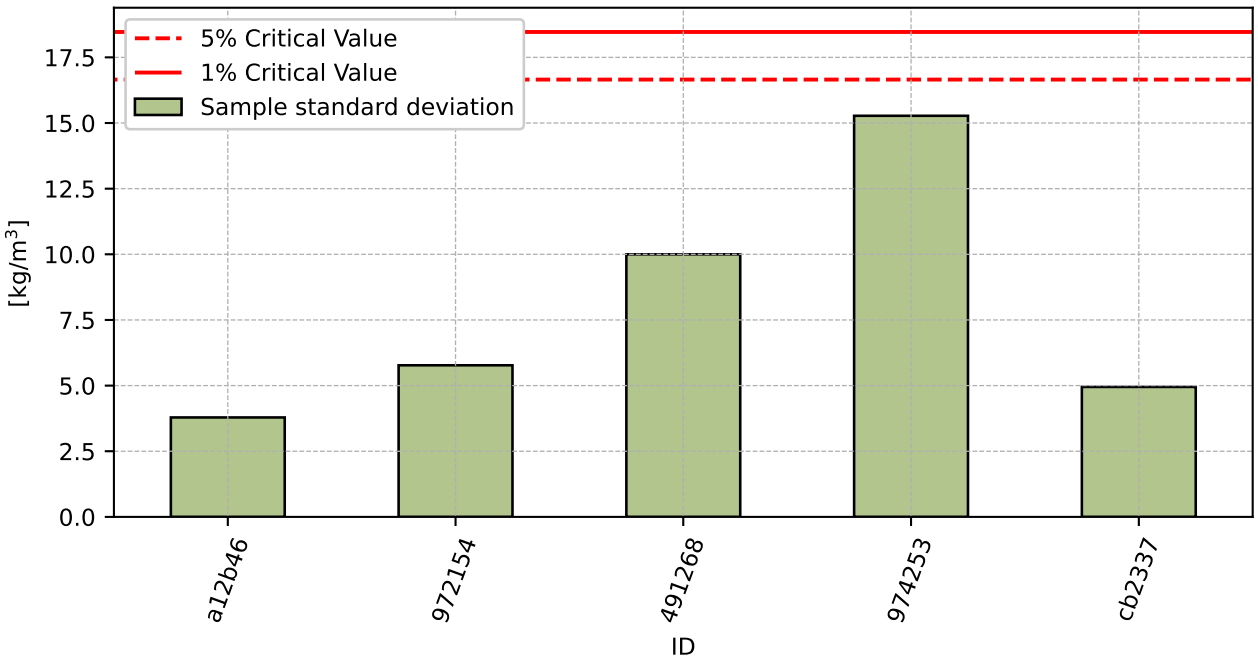

Figure 86: **Cochran's test** - sample standard deviations

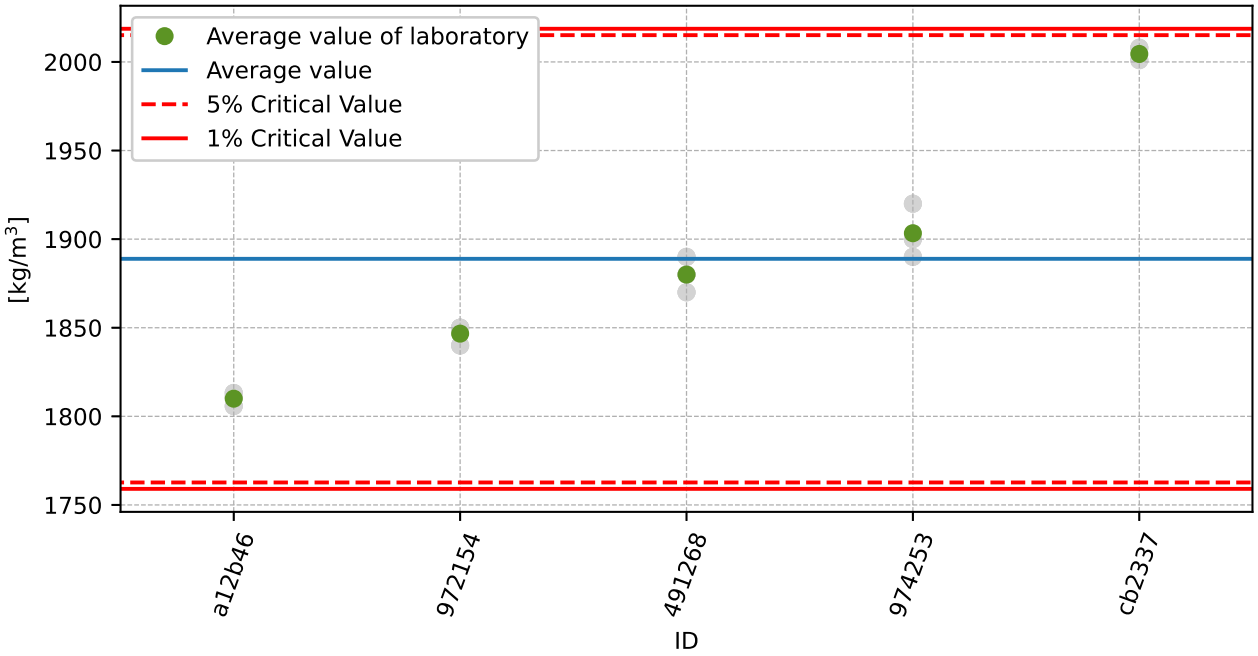

Figure 87: **Grubbs' test** - average values

13.3 Mandel's Statistics

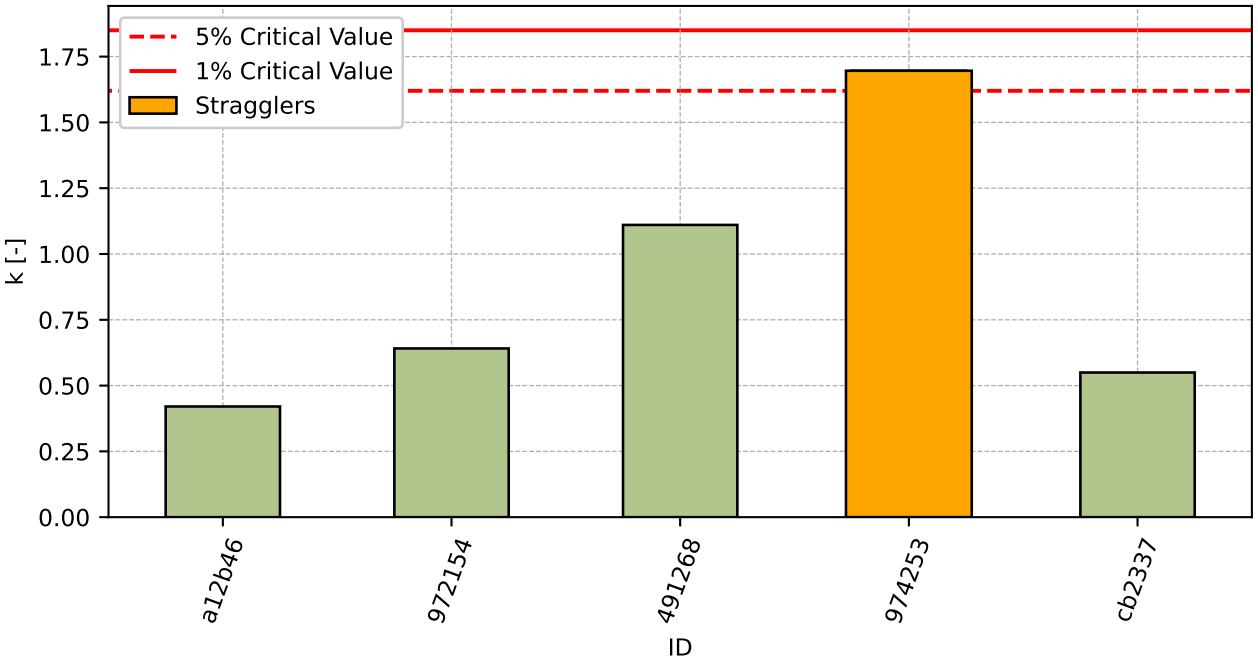

Figure 88: Intralaboratory Consistency Statistic

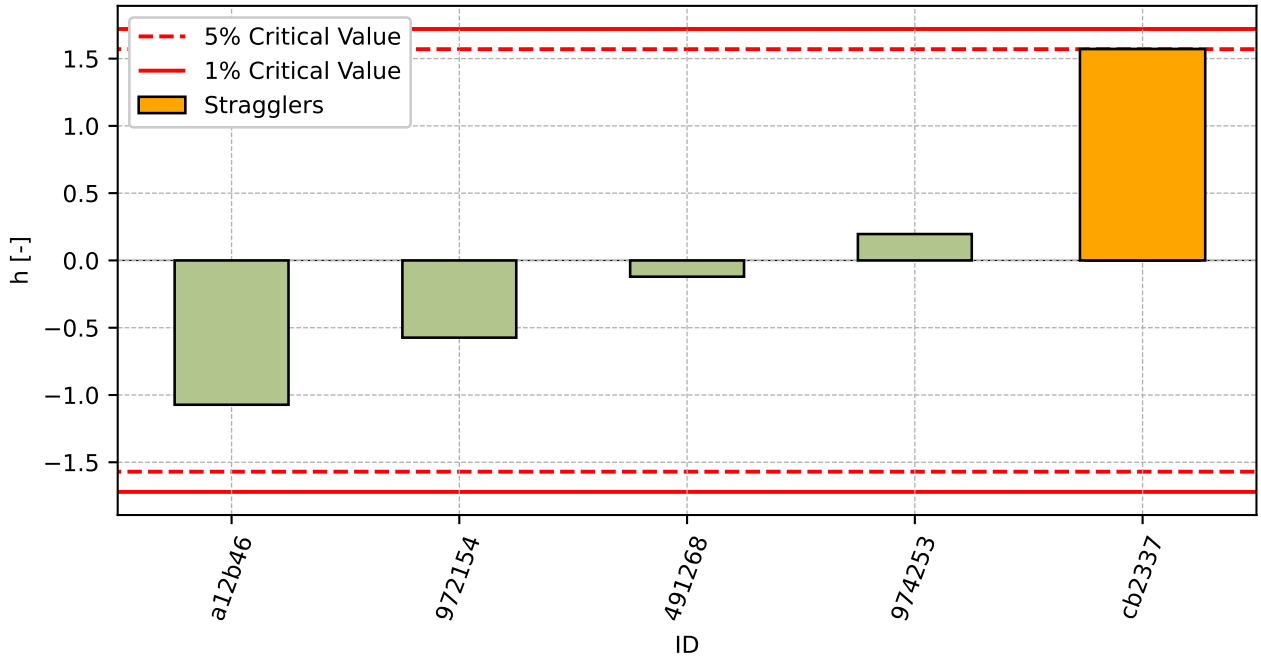

Figure 89: Interlaboratory Consistency Statistic

13.4 Descriptive statistics

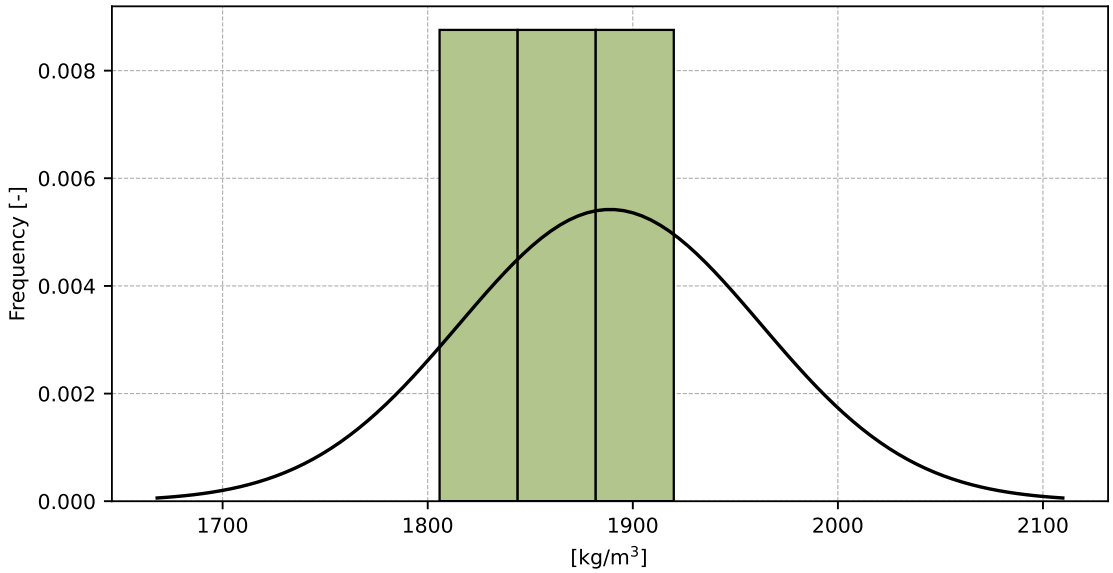

Figure 90: Histogram of all test results

Table 32: Descriptive statistics

Characteristics	[kg/m³]
Average value – $\bar{x}$	1889
Sample standard deviation – s	73.6
Asigned value – x^*	1889
Robust standard deviation – s^*	74.6
Measurement uncertainty of asigned value – u_X	41.7
p-value of normality test	0.539 [-]
Interlaboratory standard deviation – s_L	73.4
Repeatability standard deviation – s_r	9.0
Reproducibility standard deviation – s_R	74.0
Repeatability – r	25
Reproducibility – R	207

13.5 Evaluation of Performance Statistics

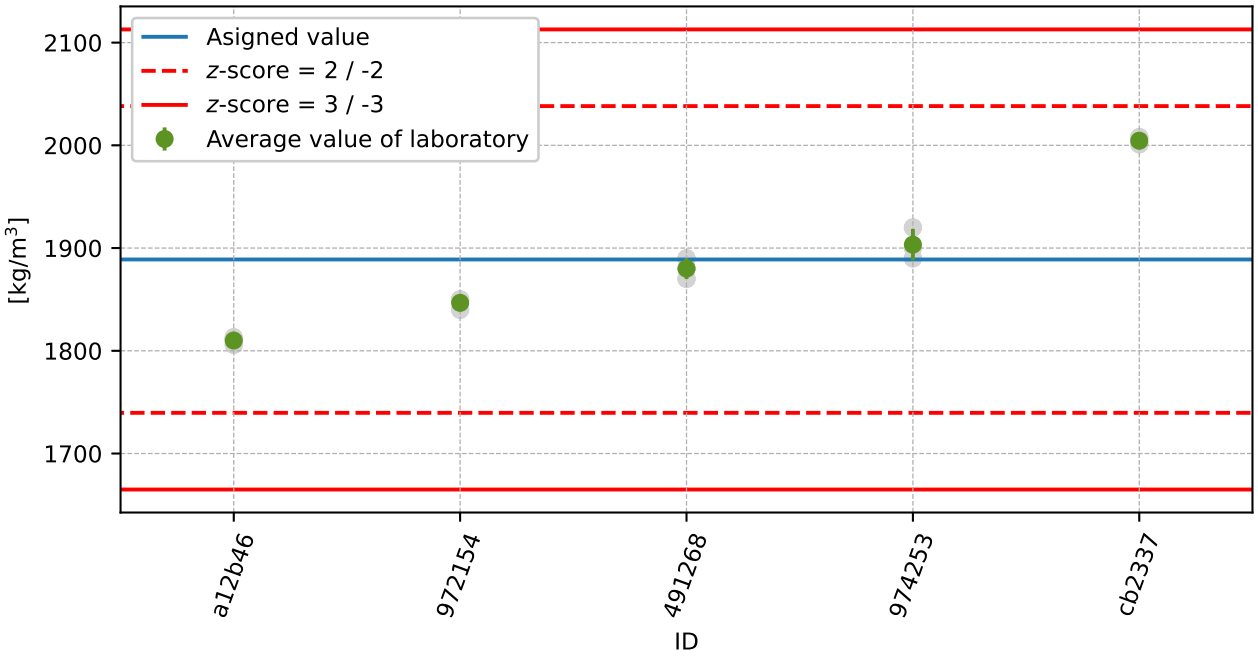

Figure 91: Average values and sample standard deviations

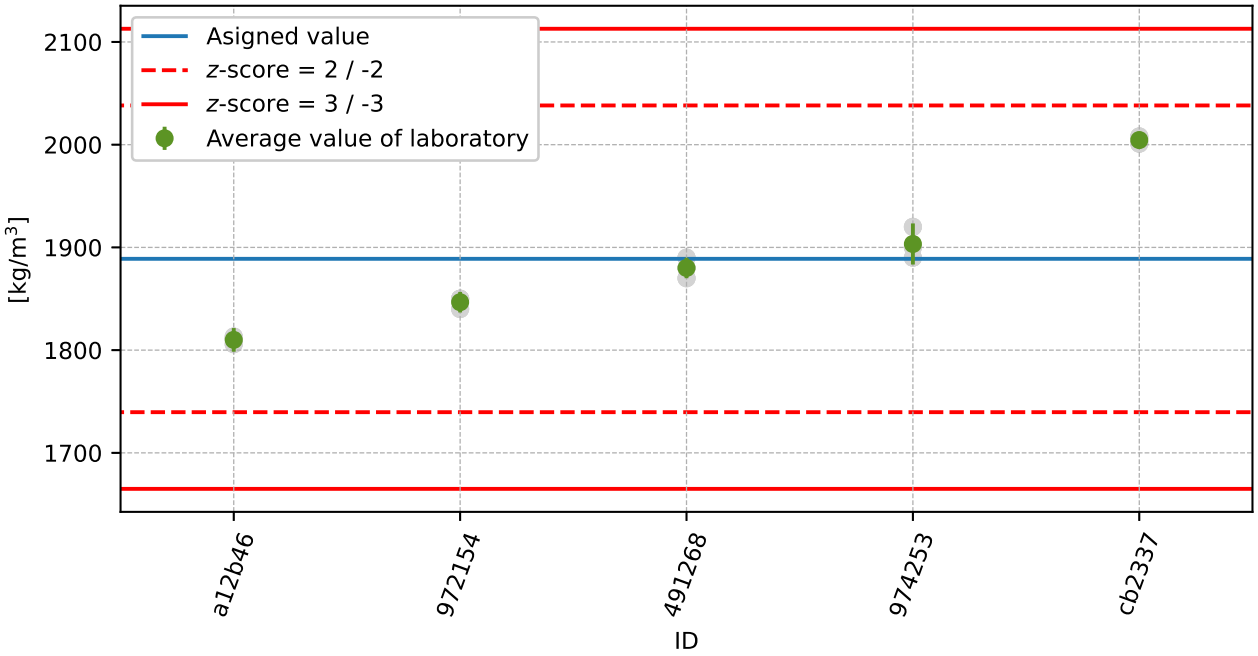

Figure 92: Average values and extended uncertainties of measurement

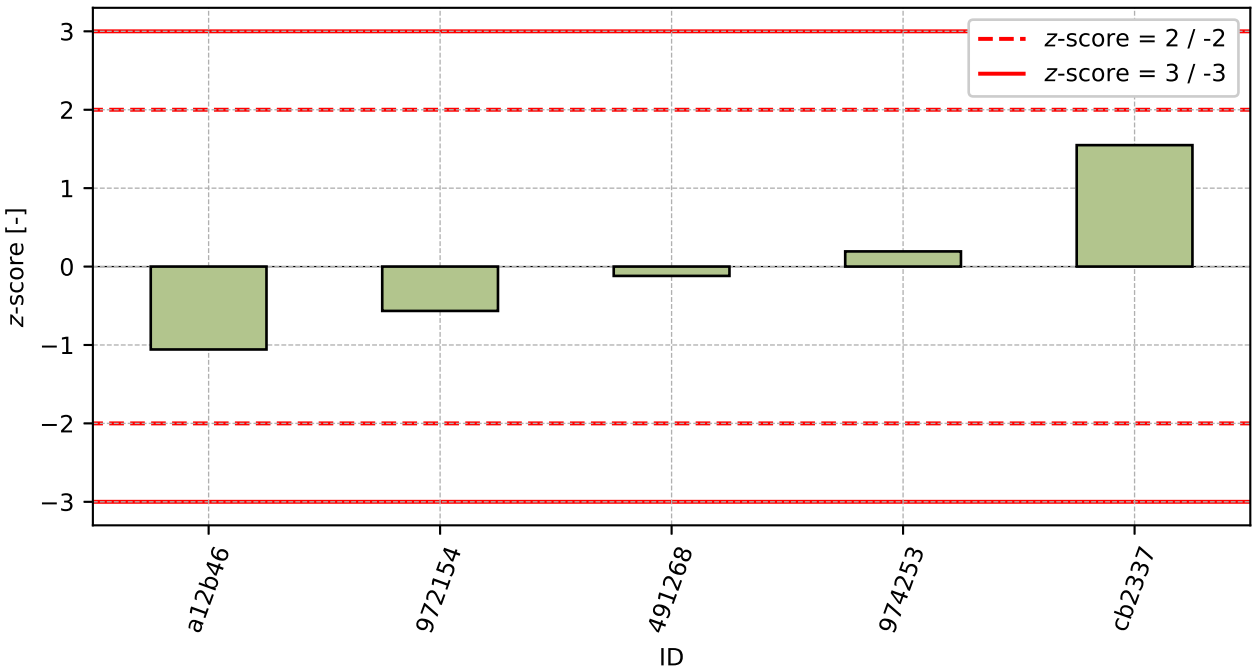

Figure 93: z-score

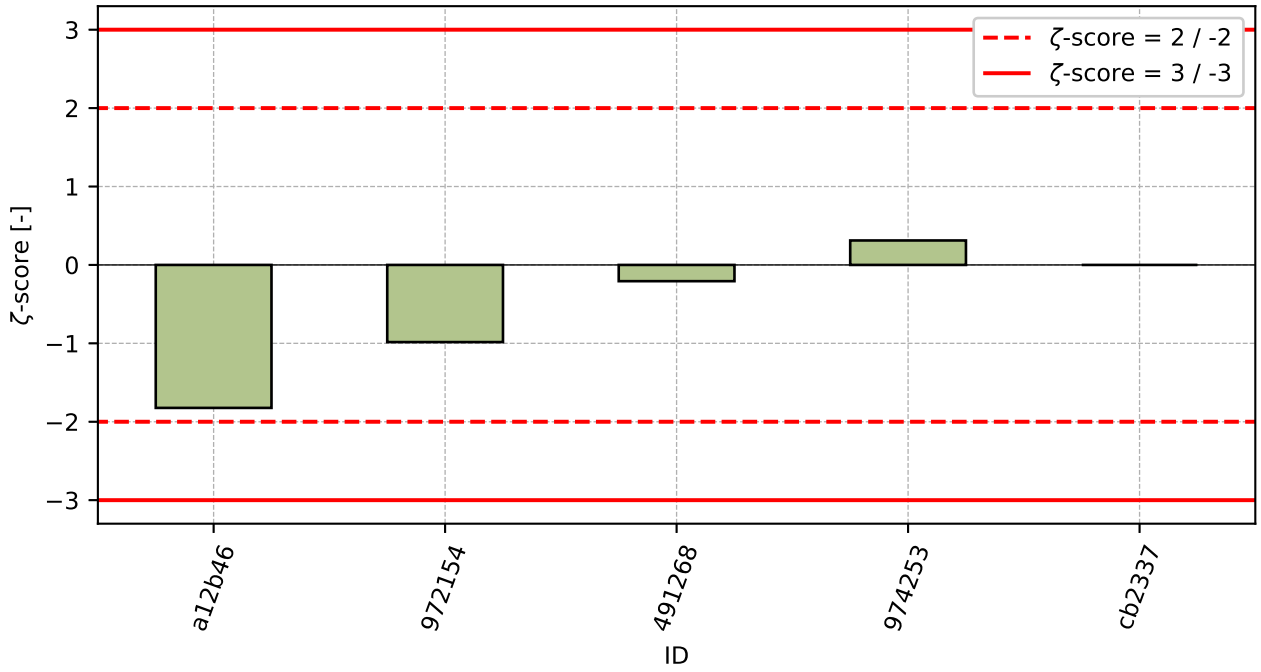

Figure 94: ζ-score

Table 33: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a12b46	-1.06	-1.82
972154	-0.57	-0.98
491268	-0.12	-0.21
974253	0.19	0.31
cb2337	1.55	-

14 Appendix – EN 1015-11 – Strength

14.1 Flexural Strength

14.1.1 Test results

Table 34: 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/mm^2]			u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
3f4460	1.6	2.0	2.0	0.1	1.9	0.23	12.37
491268	2.6	2.2	2.4	-	2.4	0.18	7.42
c601d9	2.5	2.6	2.6	-	2.6	0.06	2.25
240075	2.7	2.5	2.8	0.1	2.7	0.15	5.73
974253	3.1	2.5	2.6	0.3	2.7	0.32	11.76
a12b46	2.9	2.7	2.8	0.5	2.8	0.09	3.3
972154	2.8	2.8	3.2	0.6	2.9	0.23	8.01
59b4fc	3.0	3.2	2.8	0.1	3.0	0.18	5.79
323f82	3.1	3.1	2.9	0.1	3.0	0.1	3.24
3a1088	2.7	3.4	3.4	0.2	3.2	0.42	13.17
781562	3.2	3.4	3.4	0.1	3.3	0.15	4.61
cb2337	3.4	3.3	3.3	0.0	3.4	0.06	1.86
b5292e	3.6	3.4	3.4	0.3	3.5	0.12	3.33

14.1.2 The Numerical Procedure for Determining Outliers

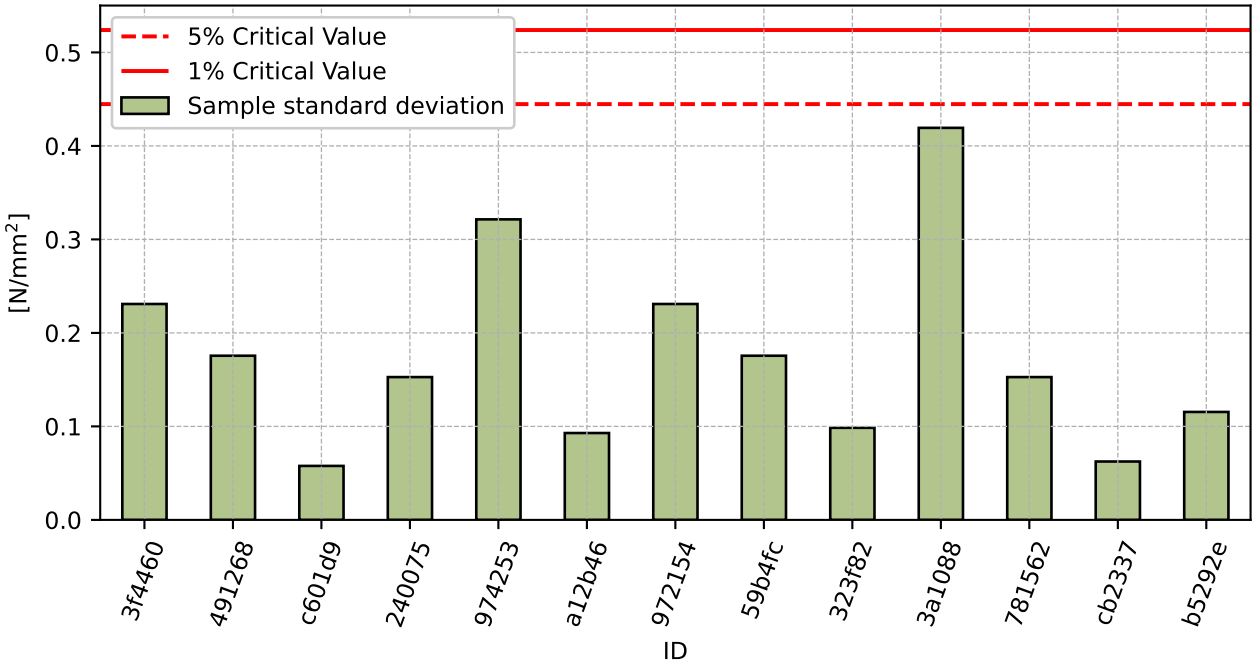

Figure 95: **Cochran's test** - sample standard deviations

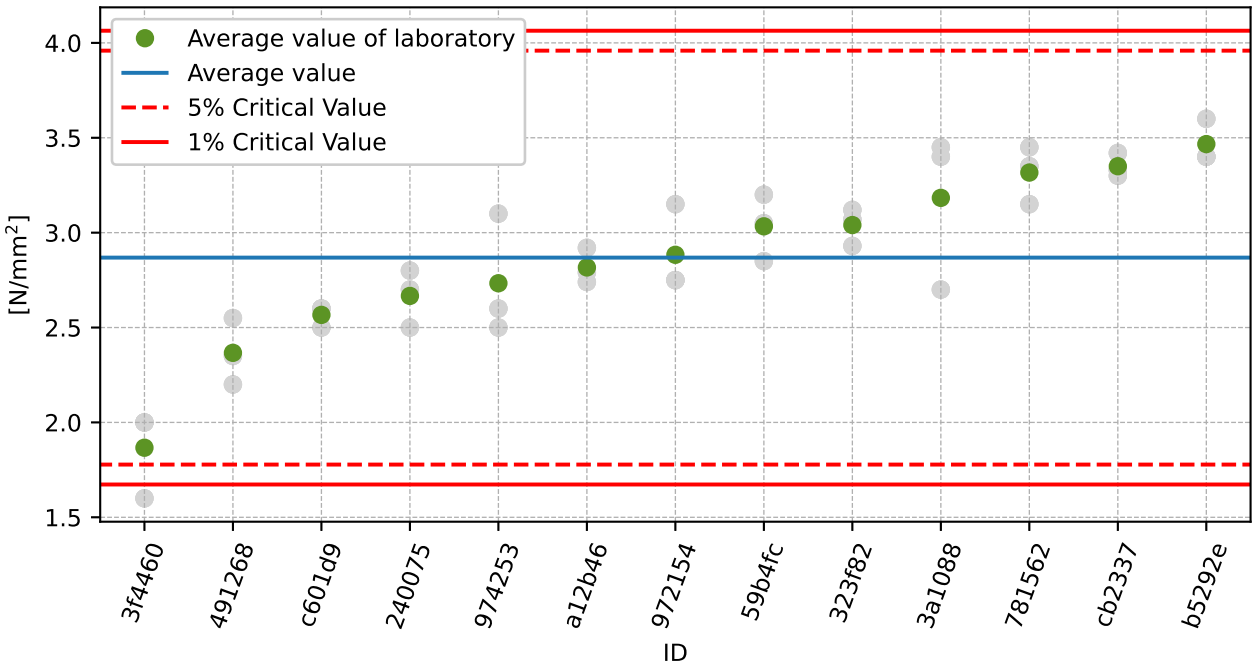

Figure 96: **Grubbs' test** - average values

14.1.3 Mandel's Statistics

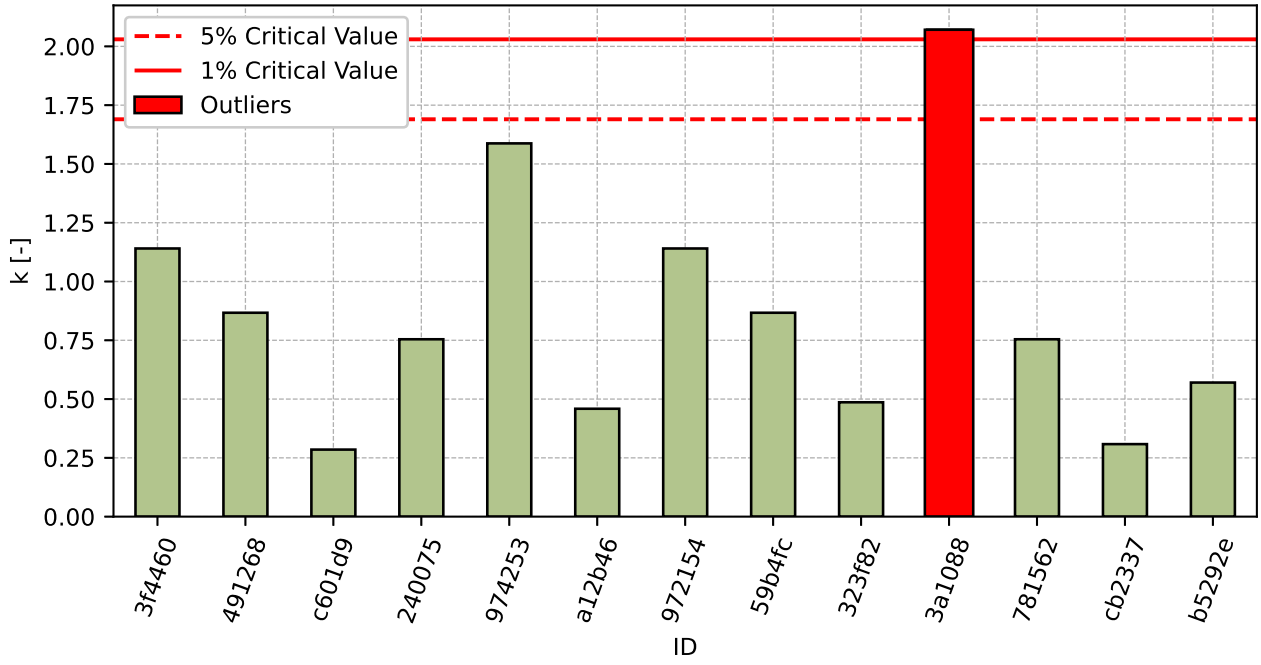

Figure 97: Intralaboratory Consistency Statistic

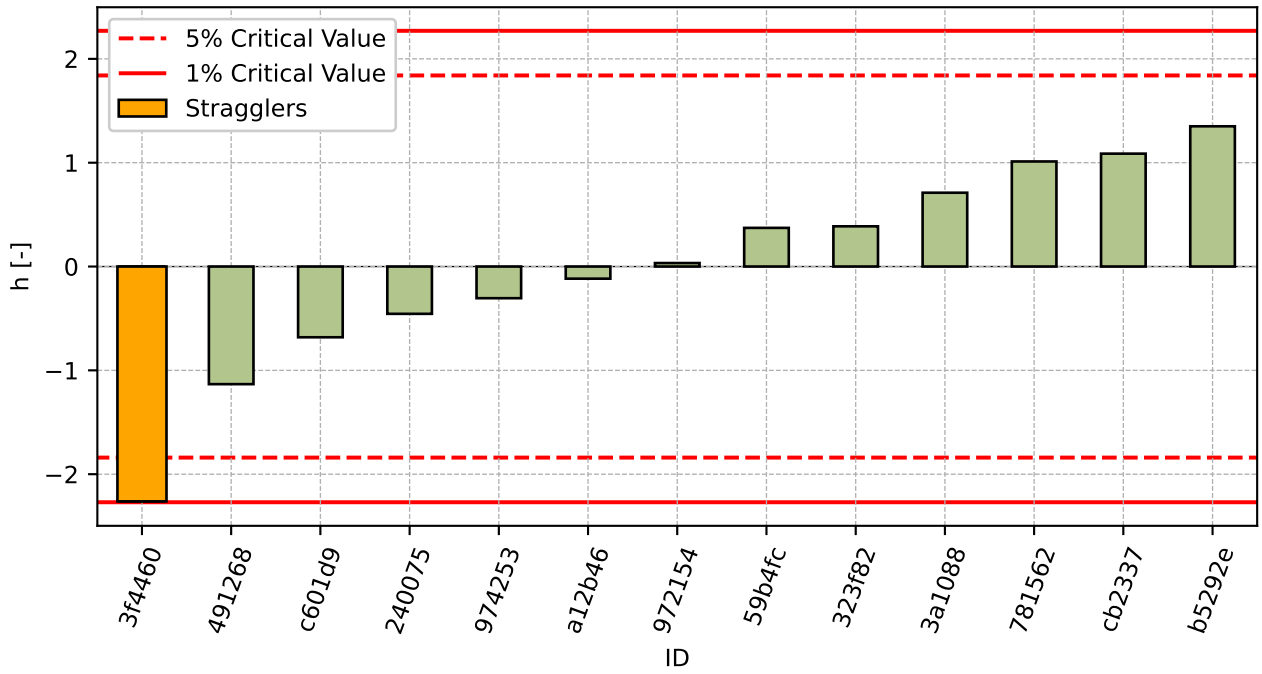

Figure 98: Interlaboratory Consistency Statistic

14.1.4 Descriptive statistics

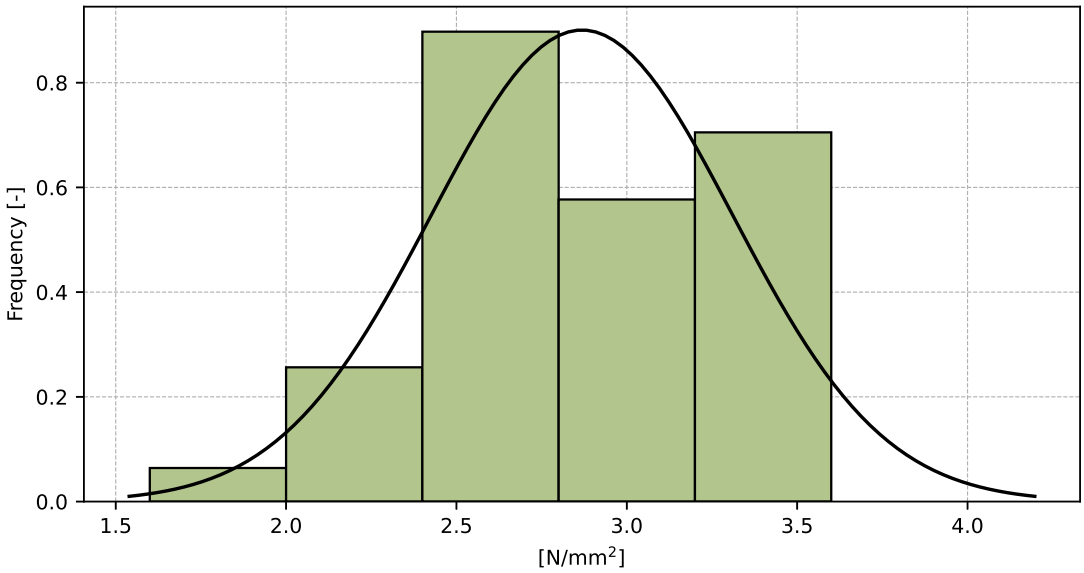

Figure 99: Histogram of all test results

Table 35: Descriptive statistics

Characteristics	**[N/mm²]**
Average value – $\bar{x}$	2.9
Sample standard deviation – s	0.44
Asigned value – x^*	2.9
Robust standard deviation – s^*	0.41
Measurement uncertainty of asigned value – u_X	0.14
p-value of normality test	0.225 [-]
Interlaboratory standard deviation – s_L	0.43
Repeatability standard deviation – s_r	0.2
Reproducibility standard deviation – s_R	0.47
Repeatability – r	0.6
Reproducibility – R	1.3

14.1.5 Evaluation of Performance Statistics

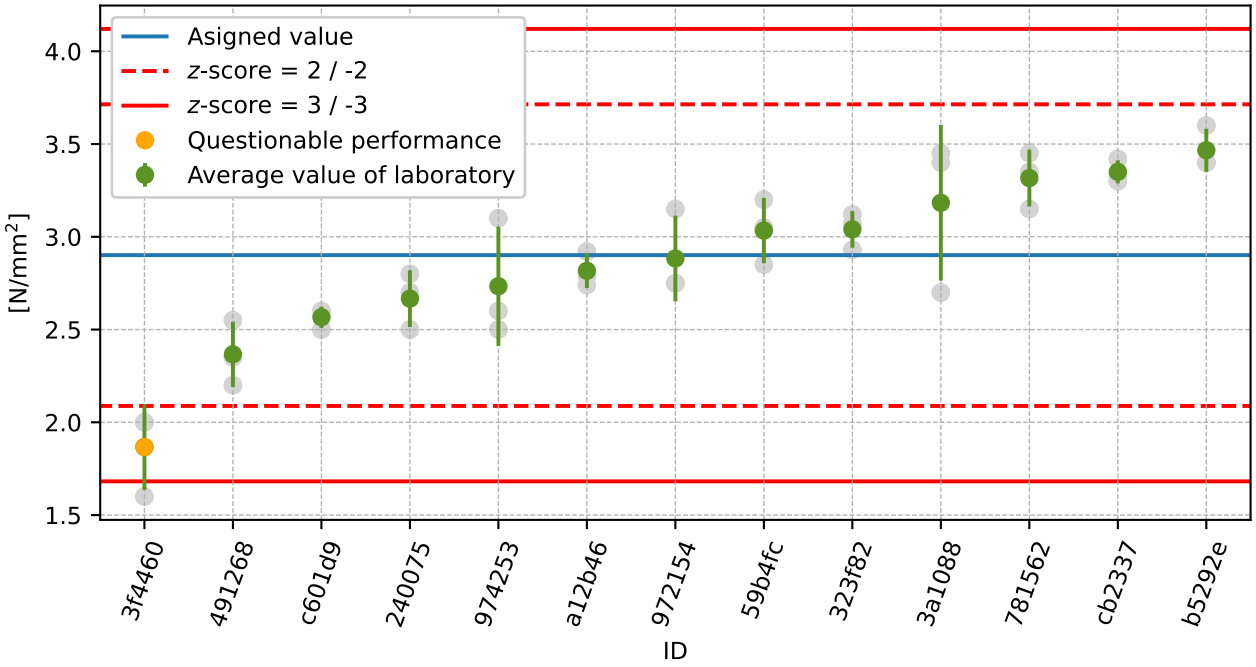

Figure 100: Average values and sample standard deviations

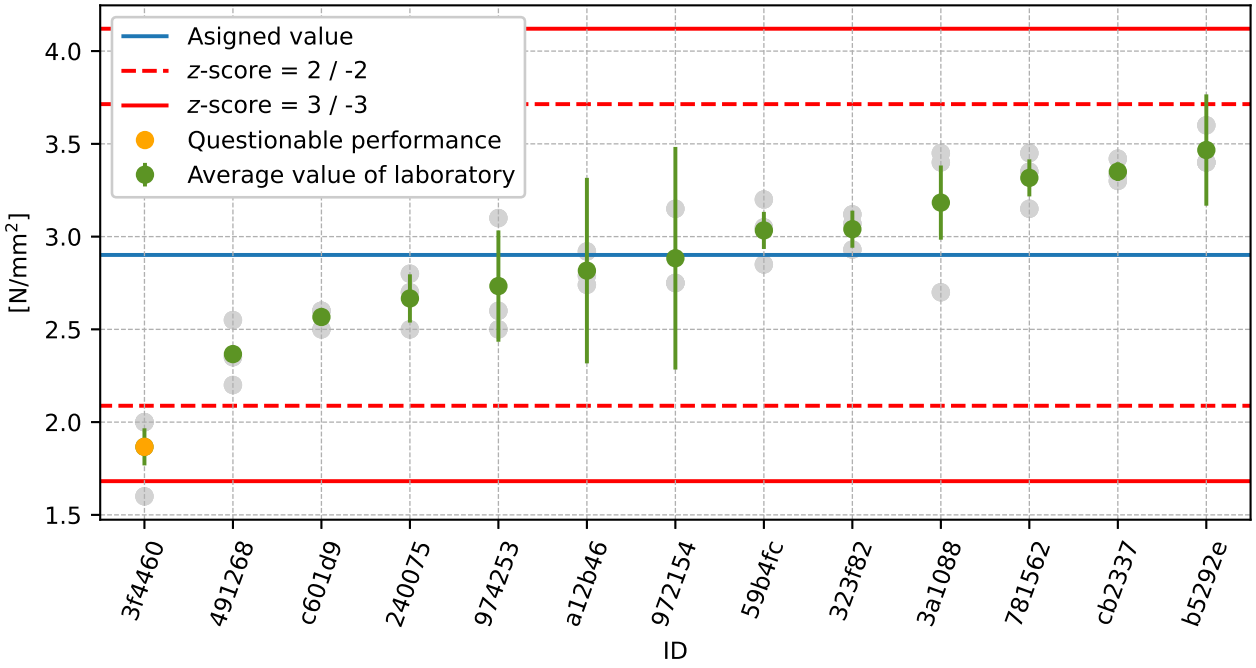

Figure 101: Average values and extended uncertainties of measurement

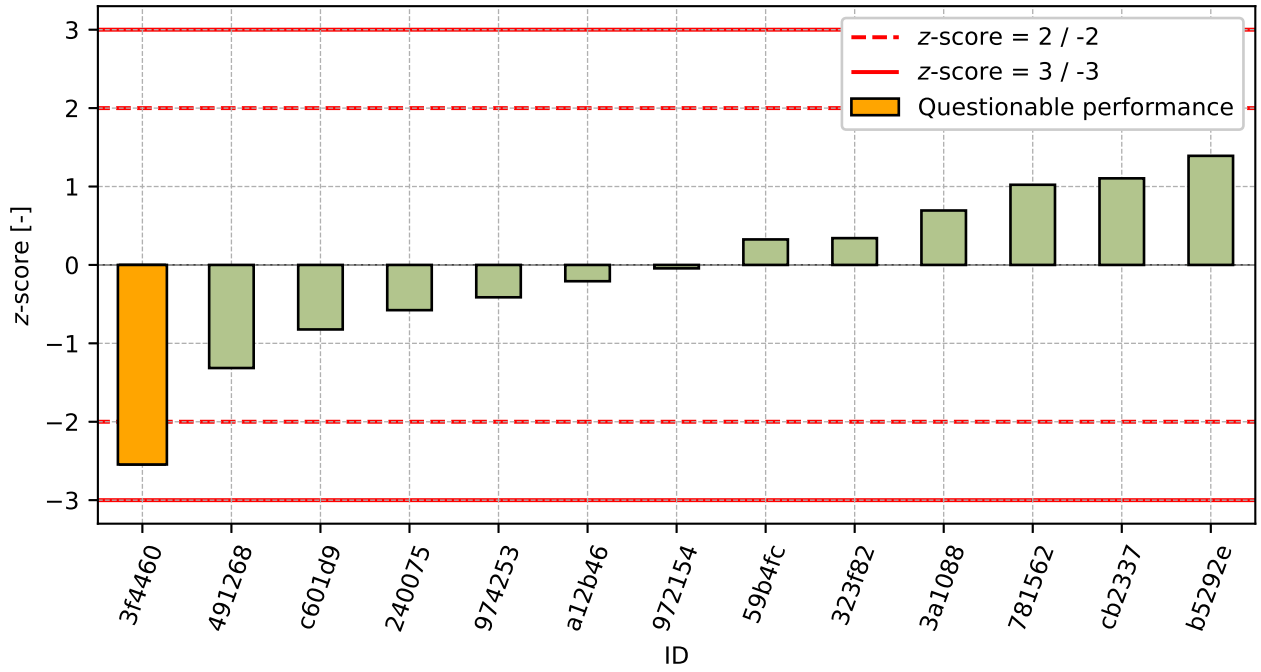

Figure 102: z-score

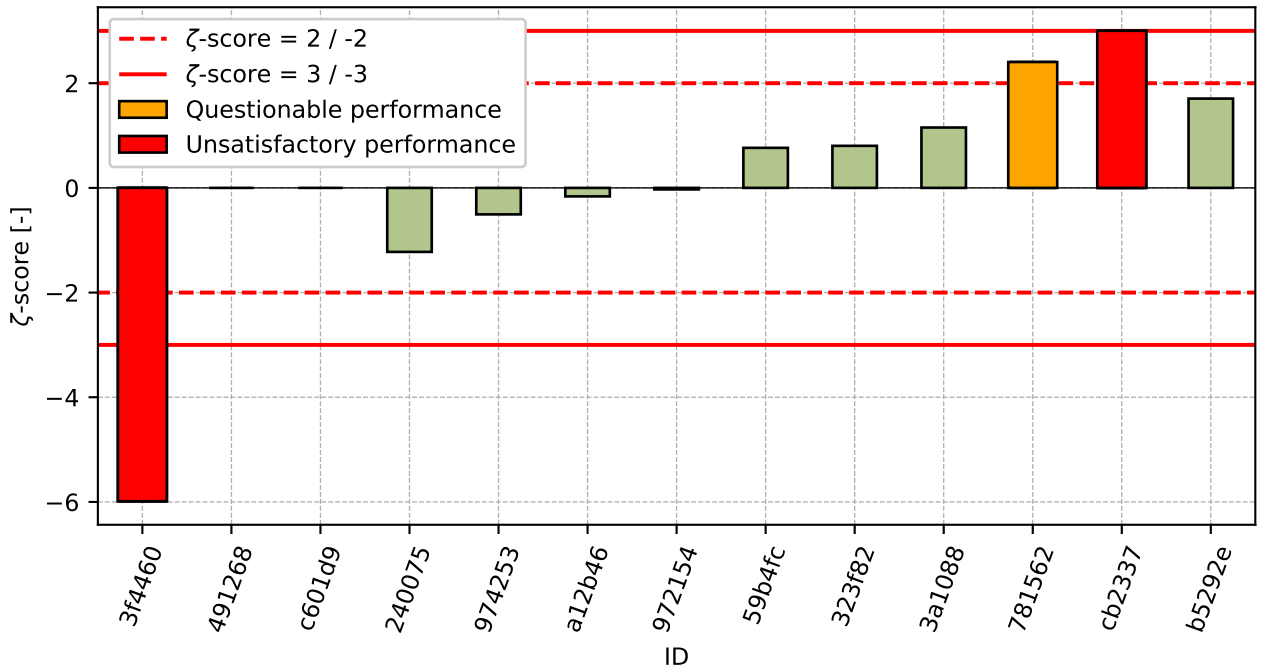

Figure 103: ζ-score

Table 36: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
3f4460	-2.55	-5.99
491268	-1.31	-
c601d9	-0.82	-
240075	-0.58	-1.22
974253	-0.41	-0.51
a12b46	-0.21	-0.16
972154	-0.04	-0.03
59b4fc	0.33	0.77
323f82	0.34	0.8
3a1088	0.69	1.15
781562	1.02	2.4
cb2337	1.1	3.0
b5292e	1.39	1.71

14.2 Compressive Strength

14.2.1 Test results

Table 37: 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/mm^2]						u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
491268	8.9	8.8	8.8	8.4	8.0	8.9	-	8.6	0.36	4.23
974253	9.0	9.3	9.1	9.5	9.1	9.1	0.6	9.2	0.18	2.0
3f4460	8.5	9.6	9.5	9.0	10.1	10.3	0.6	9.5	0.67	7.03
323f82	9.1	9.4	9.7	10.0	9.8	9.8	0.3	9.6	0.33	3.41
972154	9.8	9.9	9.2	9.5	9.9	10.2	0.4	9.8	0.38	3.91
cb2337	10.3	9.9	9.8	9.7	10.0	10.0	0.0	10.0	0.18	1.83
a12b46	10.3	10.5	9.8	9.7	10.6	10.4	0.5	10.2	0.37	3.6
3a1088	11.1	11.6	11.2	11.4	10.8	11.1	-	11.2	0.28	2.47
781562	11.0	11.2	11.6	11.3	11.1	11.4	0.5	11.2	0.19	1.73
240075	12.1	11.5	11.6	11.4	11.8	12.0	0.5	11.7	0.28	2.39
b5292e	11.4	11.8	11.7	12.0	11.6	12.1	0.5	11.8	0.26	2.19
c601d9	12.2	12.0	12.4	12.0	11.9	11.9	-	12.1	0.18	1.45
59b4fc	12.0	12.0	12.5	13.0	11.7	11.6	0.2	12.1	0.55	4.57

14.2.2 The Numerical Procedure for Determining Outliers

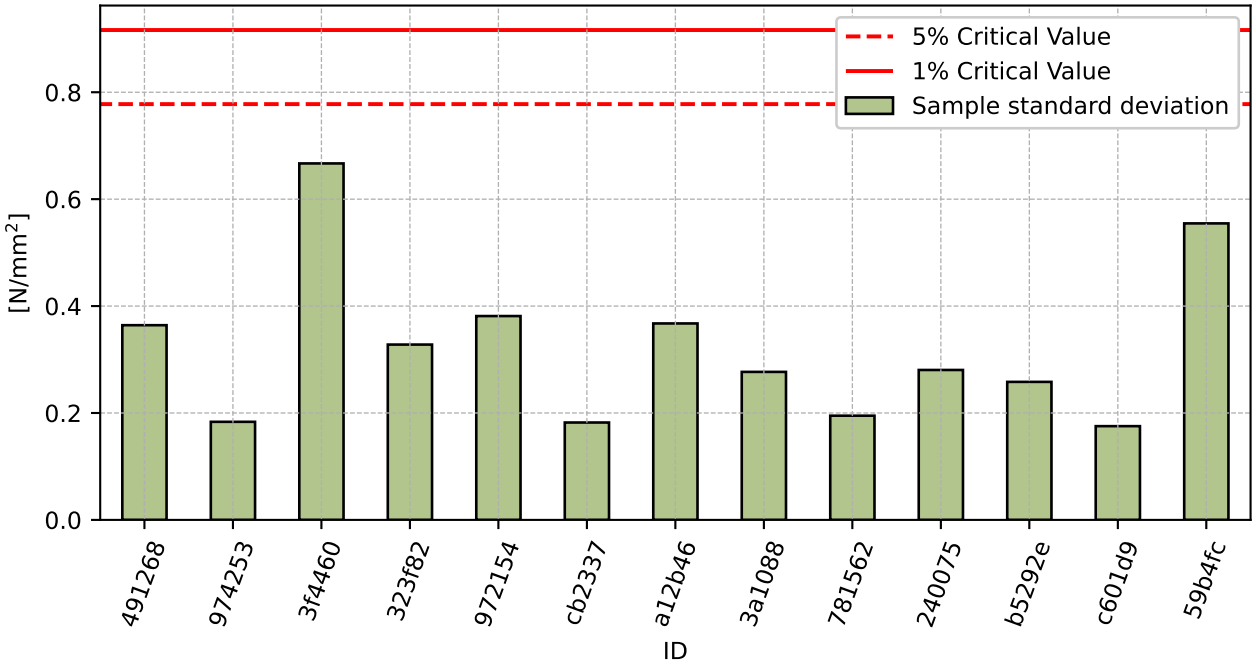

Figure 104: **Cochran's test** - sample standard deviations

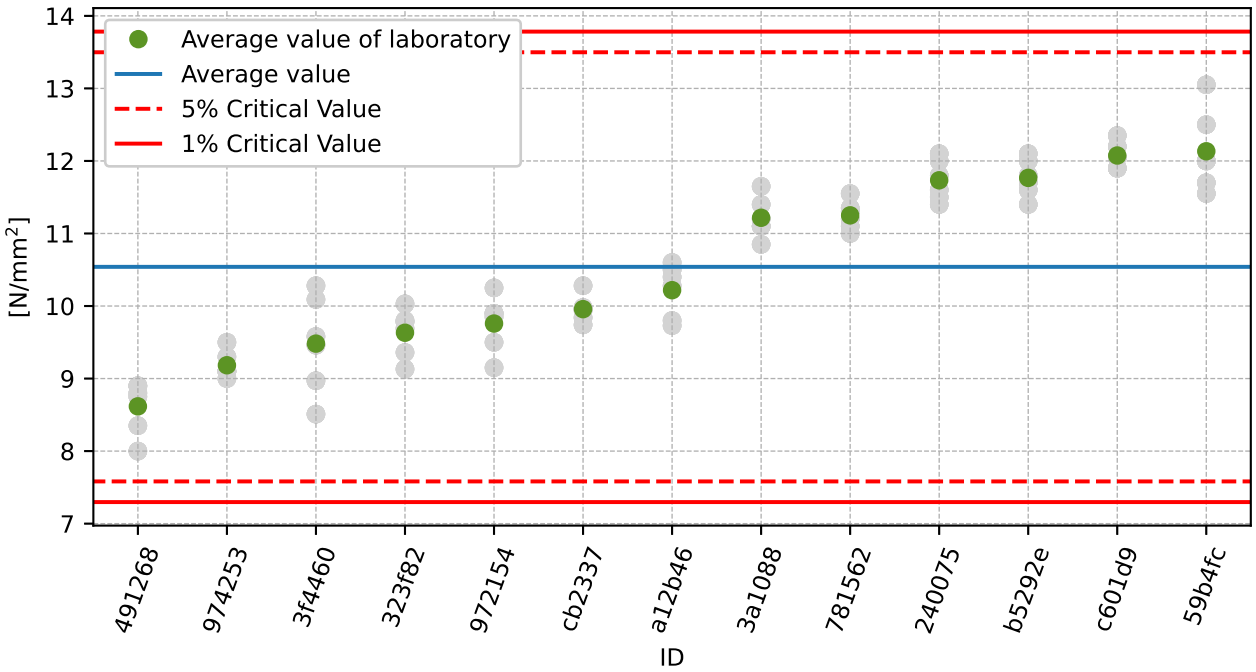

Figure 105: **Grubbs' test** - average values

14.2.3 Mandel's Statistics

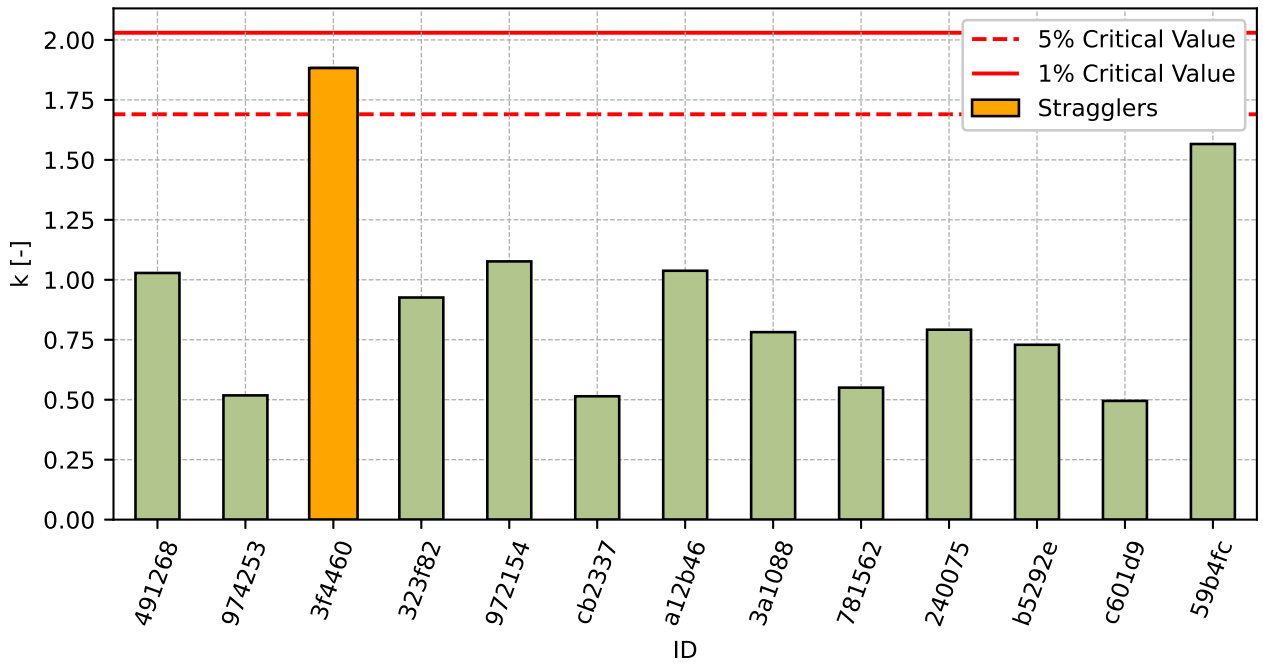

Figure 106: Intralaboratory Consistency Statistic

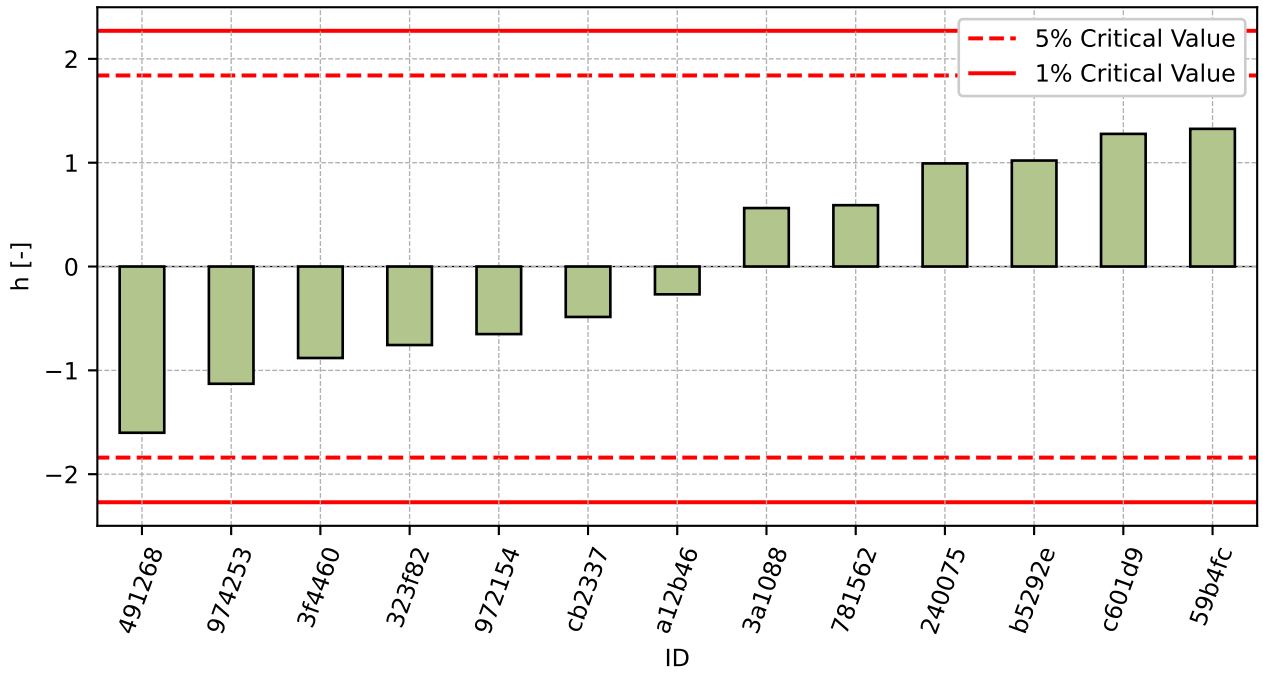

Figure 107: Interlaboratory Consistency Statistic

14.2.4 Descriptive statistics

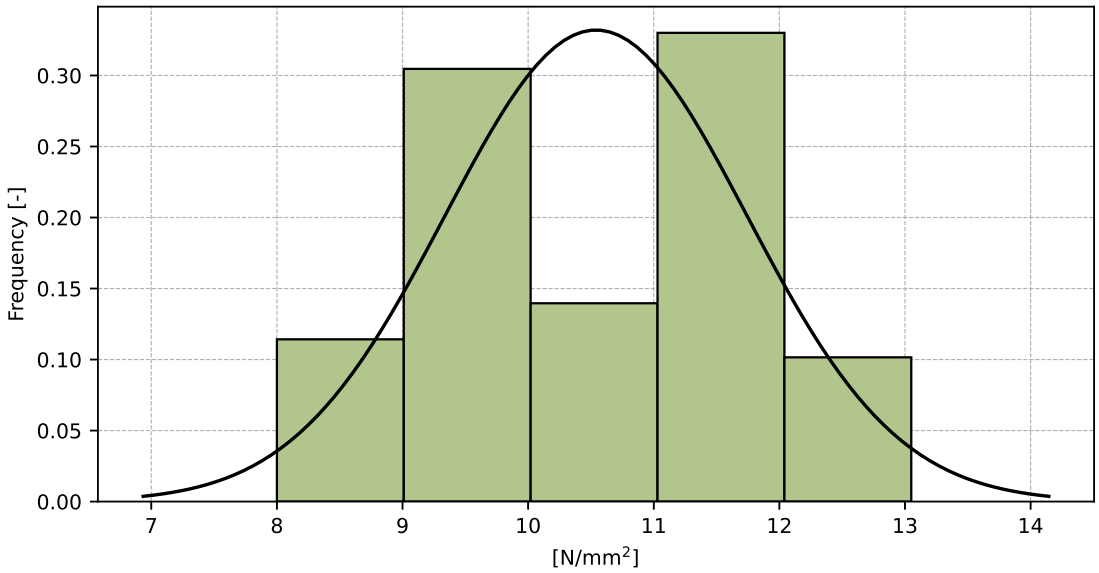

Figure 108: Histogram of all test results

Table 38: Descriptive statistics

Characteristics	[N/mm²]
Average value – $\bar{x}$	10.5
Sample standard deviation – s	1.2
Asigned value – x^*	10.5
Robust standard deviation – s^*	1.31
Measurement uncertainty of asigned value – u_X	0.45
p-value of normality test	0.0 [-]
Interlaboratory standard deviation – s_L	1.19
Repeatability standard deviation – s_r	0.35
Reproducibility standard deviation – s_R	1.24
Repeatability – r	1.0
Reproducibility – R	3.5

14.2.5 Evaluation of Performance Statistics

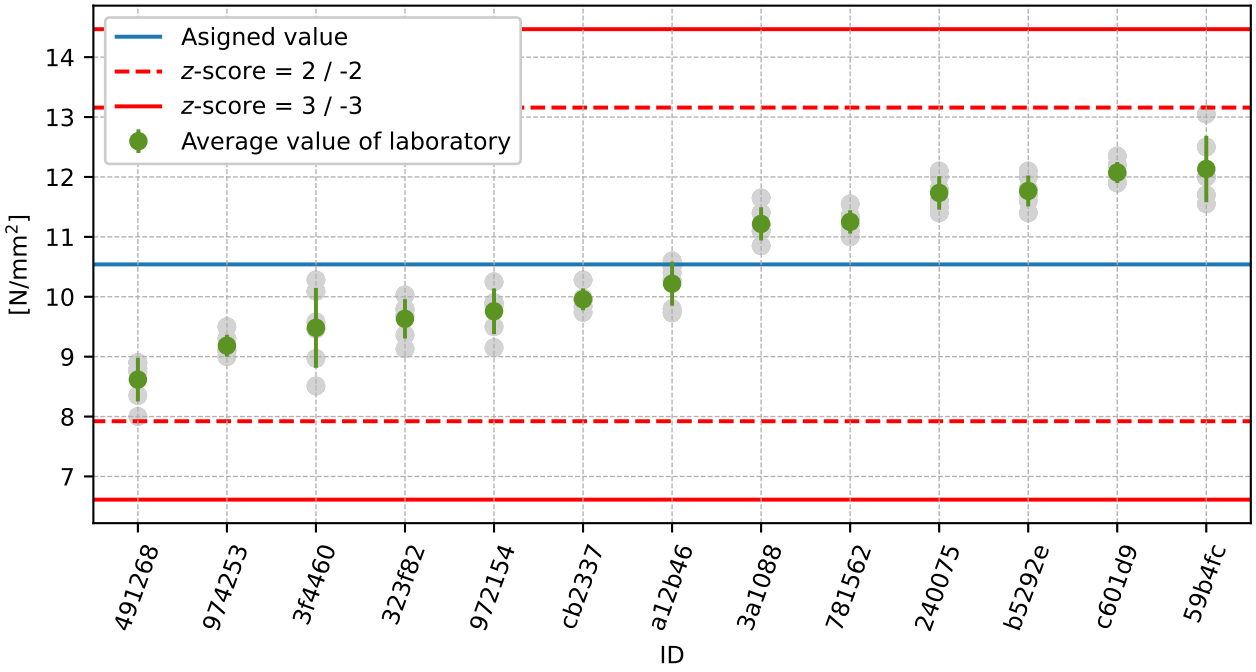

Figure 109: Average values and sample standard deviations

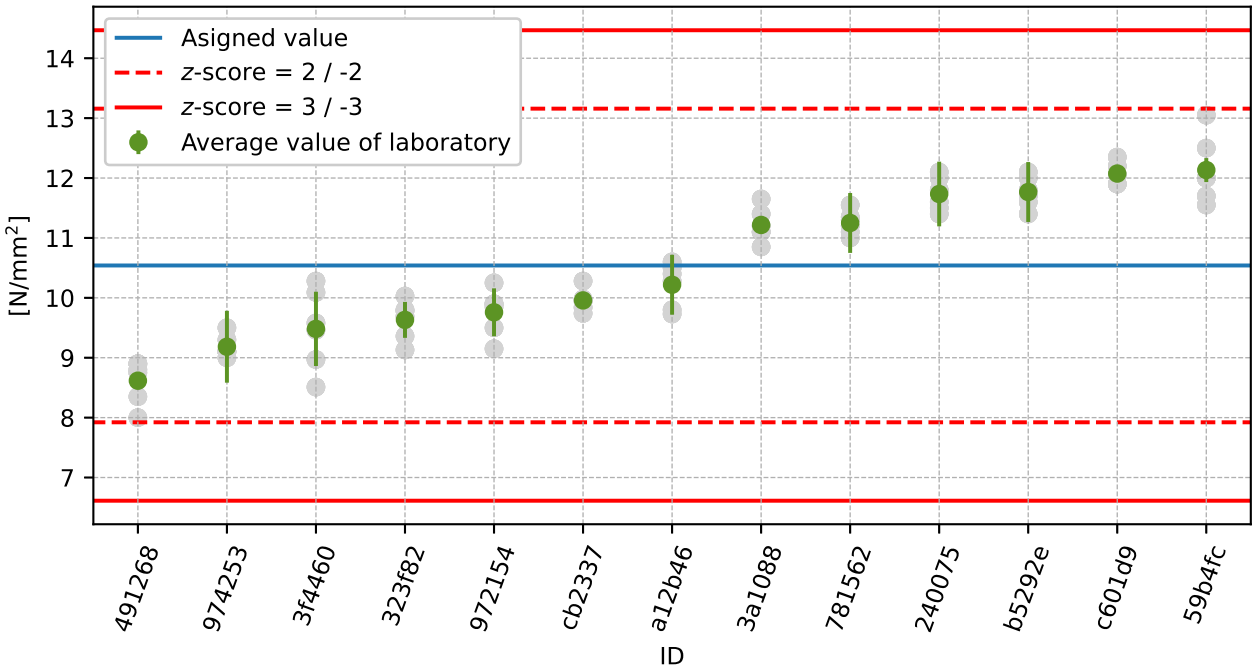

Figure 110: Average values and extended uncertainties of measurement

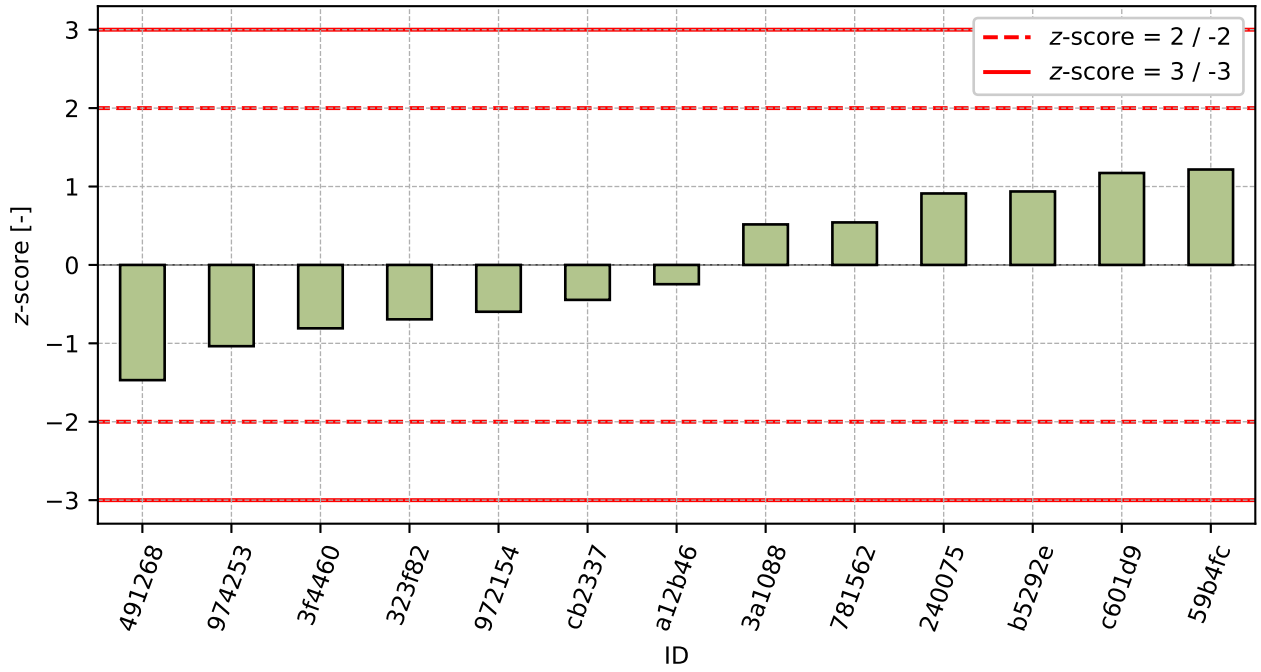

Figure 111: z-score

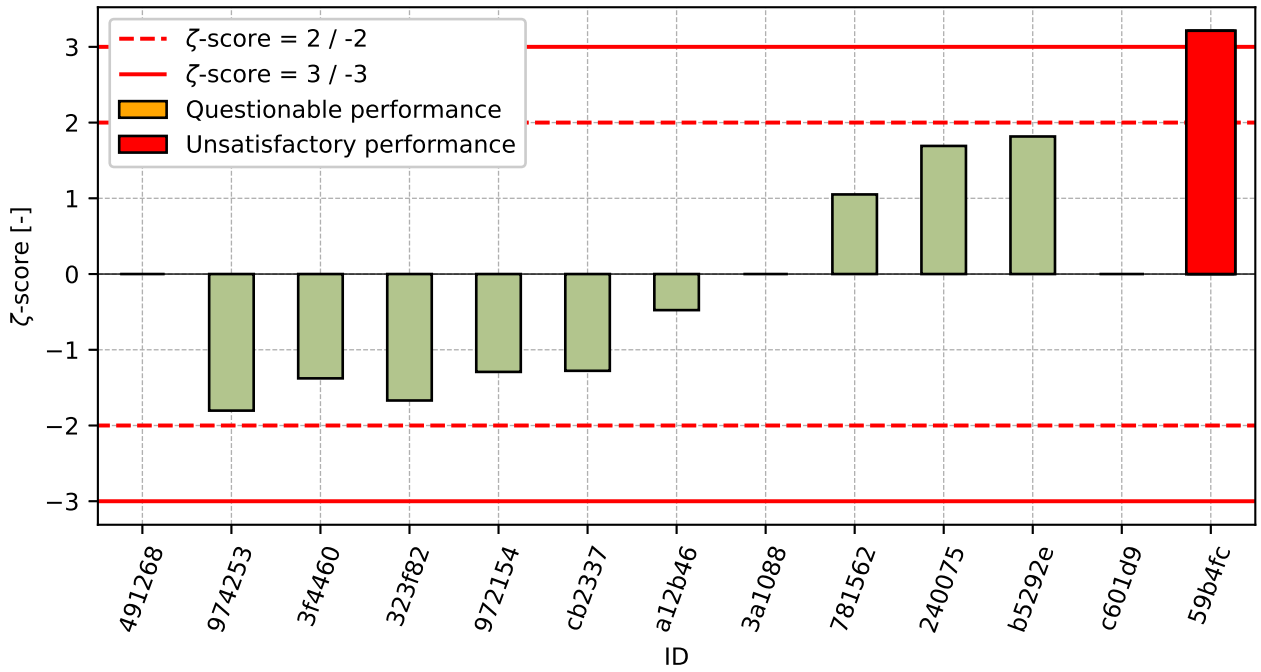

Figure 112: ζ-score

Table 39: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
491268	-1.47	-
974253	-1.04	-1.8
3f4460	-0.81	-1.38
323f82	-0.69	-1.67
972154	-0.6	-1.29
cb2337	-0.45	-1.28
a12b46	-0.25	-0.48
3a1088	0.52	-
781562	0.54	1.05
240075	0.91	1.69
b5292e	0.94	1.82
c601d9	1.17	-
59b4fc	1.22	3.21

15 Appendix – EN 1015-12 – Adhesion

15.1 Test results

Table 40: 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 [%]
736c97	0.2	0.14	0.18	0.14	0.2	0.01	0.17	0.03	17.63
972154	0.25	0.2	0.25	0.25	0.25	0.1	0.24	0.022	9.32
3f4460	0.3	0.4	0.25	0.3	0.3	0.25	0.31	0.055	17.67
a12b46	0.32	0.34	0.28	0.36	0.4	0.05	0.34	0.045	13.15
37d0bb	0.4	0.45	0.4	0.45	0.3	0.12	0.4	0.061	15.31
1a71da	0.4	0.45	0.4	0.45	0.4	-	0.42	0.027	6.52
491268	0.5	0.5	0.6	0.4	0.4	0.0	0.48	0.084	17.43

15.2 The Numerical Procedure for Determining Outliers

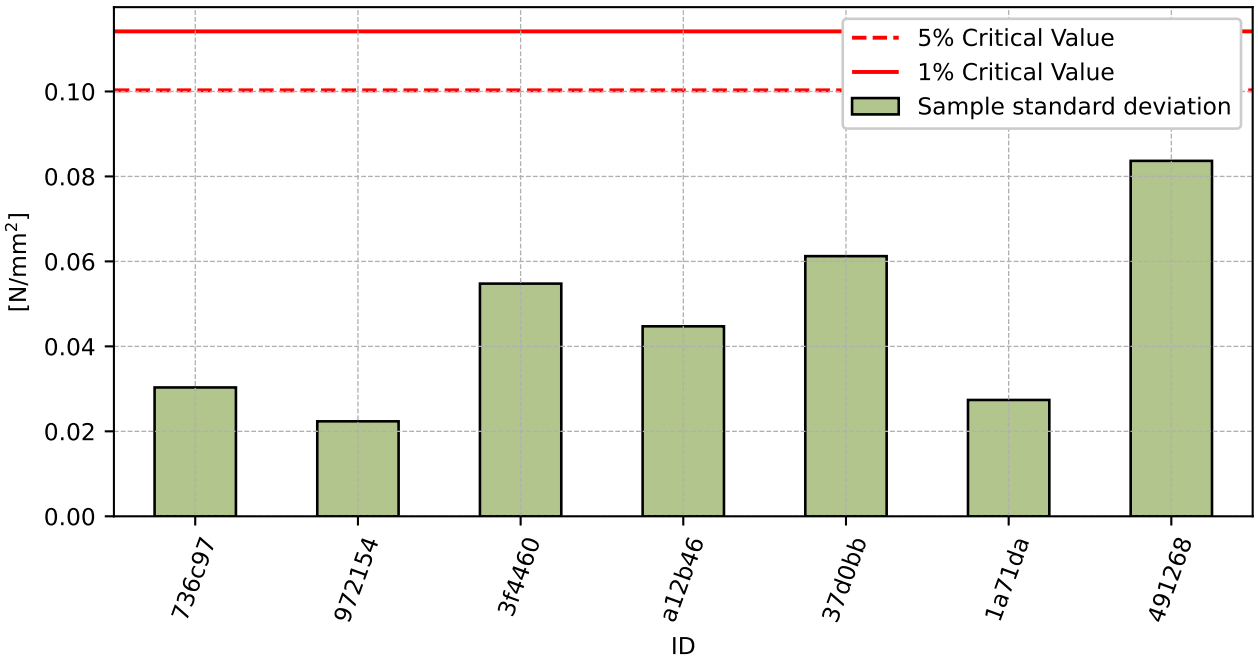

Figure 113: **Cochran's test** - sample standard deviations

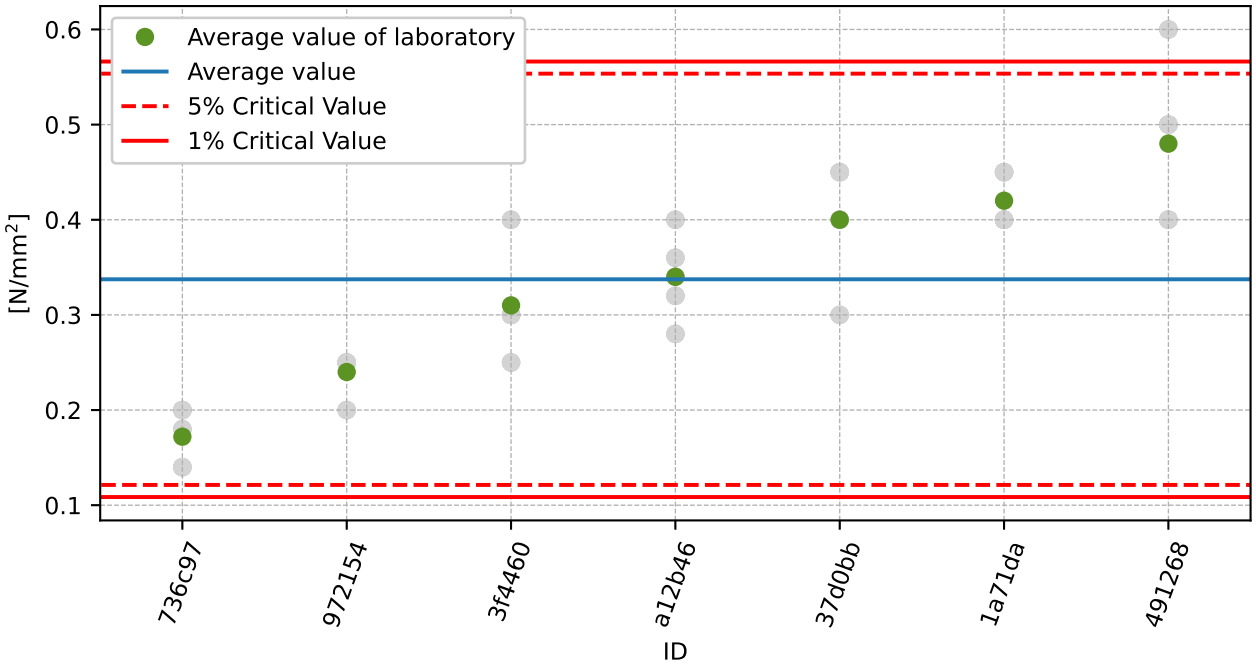

Figure 114: **Grubbs' test** - average values

15.3 Mandel's Statistics

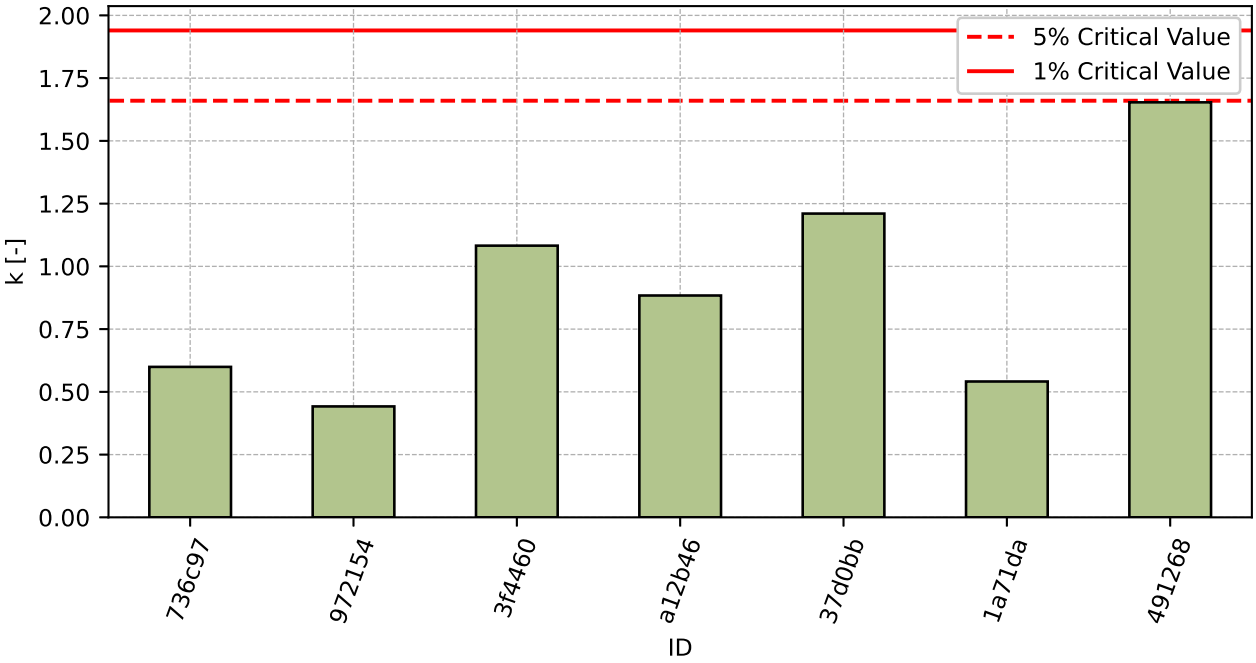

Figure 115: Intralaboratory Consistency Statistic

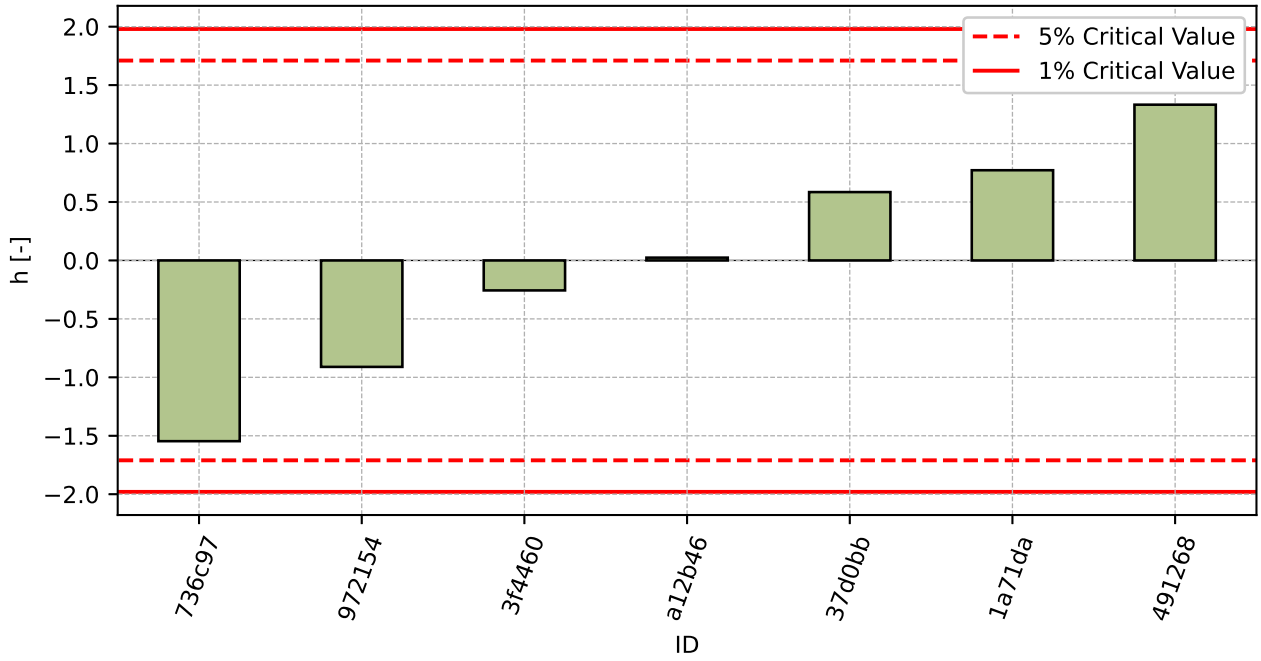

Figure 116: Interlaboratory Consistency Statistic

15.4 Descriptive statistics

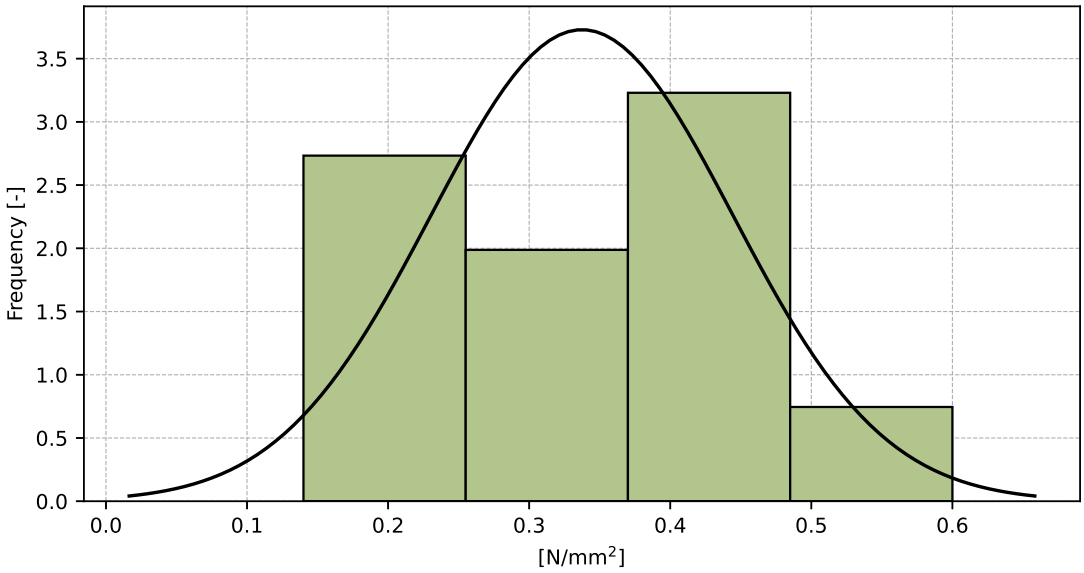

Figure 117: Histogram of all test results

Table 41: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	0.34
Sample standard deviation – s	0.107
Asigned value – x^*	0.34
Robust standard deviation – s^*	0.112
Measurement uncertainty of asigned value – u_X	0.053
p-value of normality test	0.842 [-]
Interlaboratory standard deviation – s_L	0.105
Repeatability standard deviation – s_r	0.051
Reproducibility standard deviation – s_R	0.116
Repeatability – r	0.14
Reproducibility – R	0.33

15.5 Evaluation of Performance Statistics

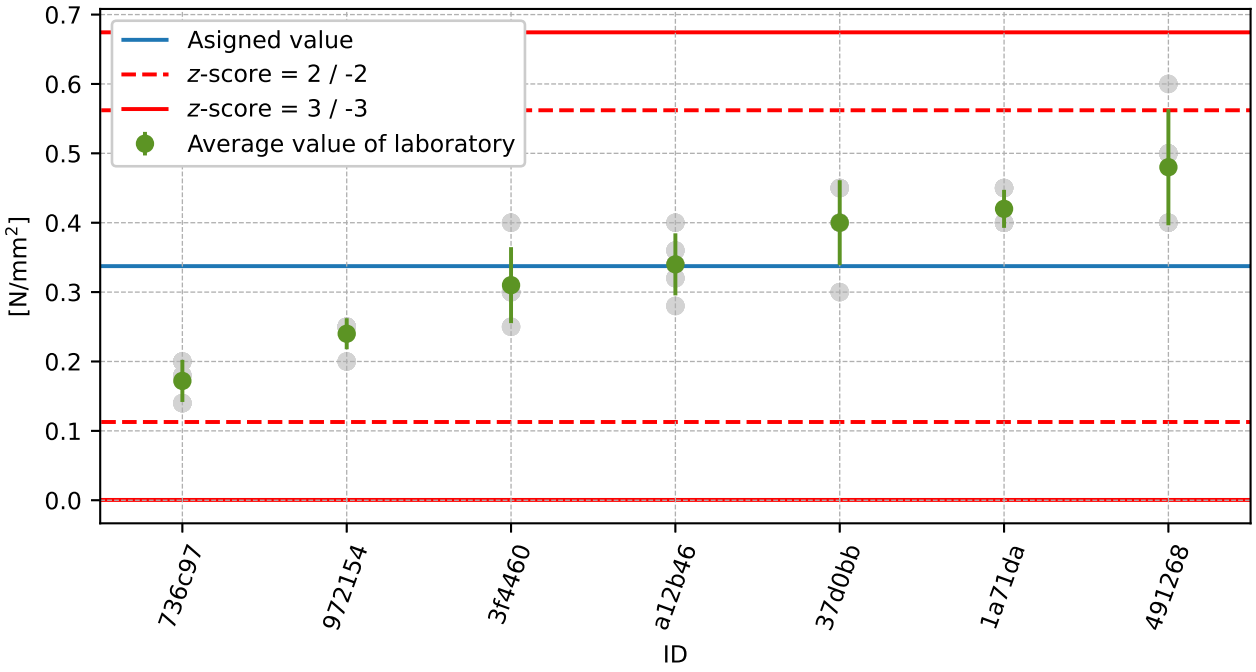

Figure 118: Average values and sample standard deviations

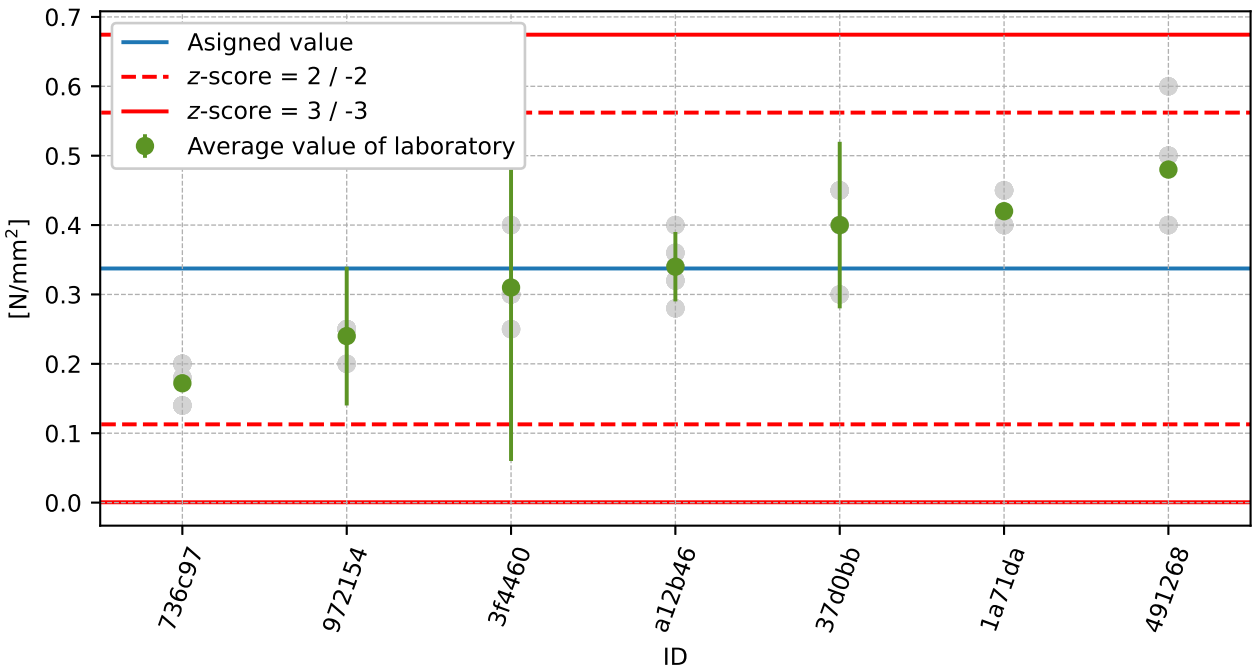

Figure 119: Average values and extended uncertainties of measurement

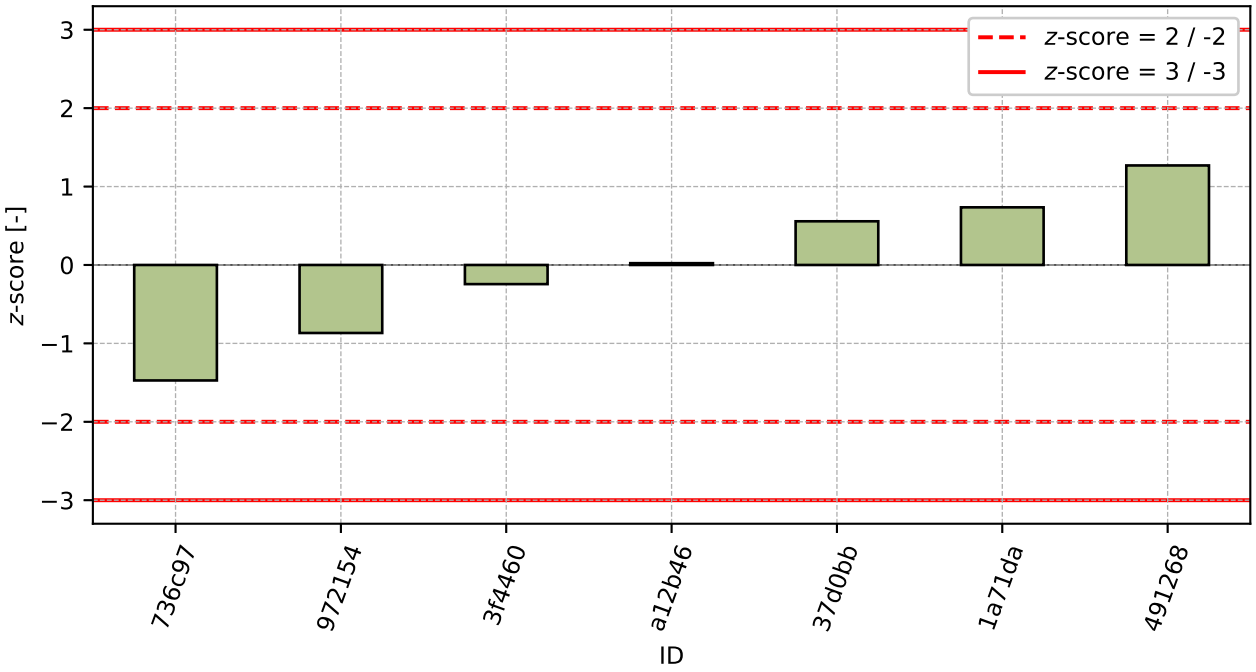

Figure 120: z-score

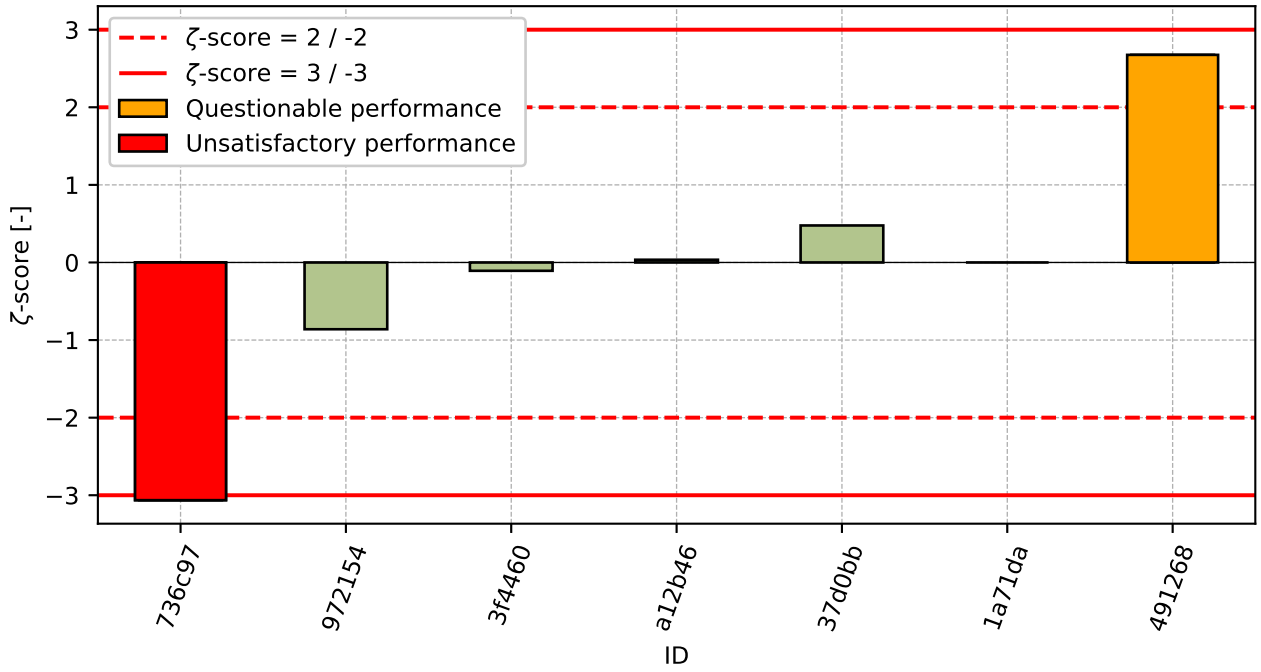

Figure 121: ζ-score

Table 42: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
736c97	-1.47	-3.06
972154	-0.87	-0.86
3f4460	-0.24	-0.11
a12b46	0.02	0.04
37d0bb	0.56	0.48
1a71da	0.74	-
491268	1.27	2.68

16 Appendix – EN 1015-18 – Capillary absorption coefficient (C_m)

16.1 Test results

Table 43: 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 [kg/(m²√min)]						u_X	$\bar{x}$	s_0	V_X [%]
a12b46	0.001	0.006	0.0	0.0	0.0	0.001	0.1	0.001	0.0021	159.75
491268	0.35	0.35	0.35	0.4	0.35	0.35	0.04	0.358	0.0204	5.7
1a71da	0.75	0.7	0.65	0.75	0.75	0.65	-	0.708	0.0492	6.94
972154	0.8	0.75	0.8	0.8	0.75	0.75	0.1	0.775	0.0274	3.53
05224d	1.0	1.0	0.9	0.9	1.0	1.05	0.24	0.975	0.0612	6.28

16.2 The Numerical Procedure for Determining Outliers

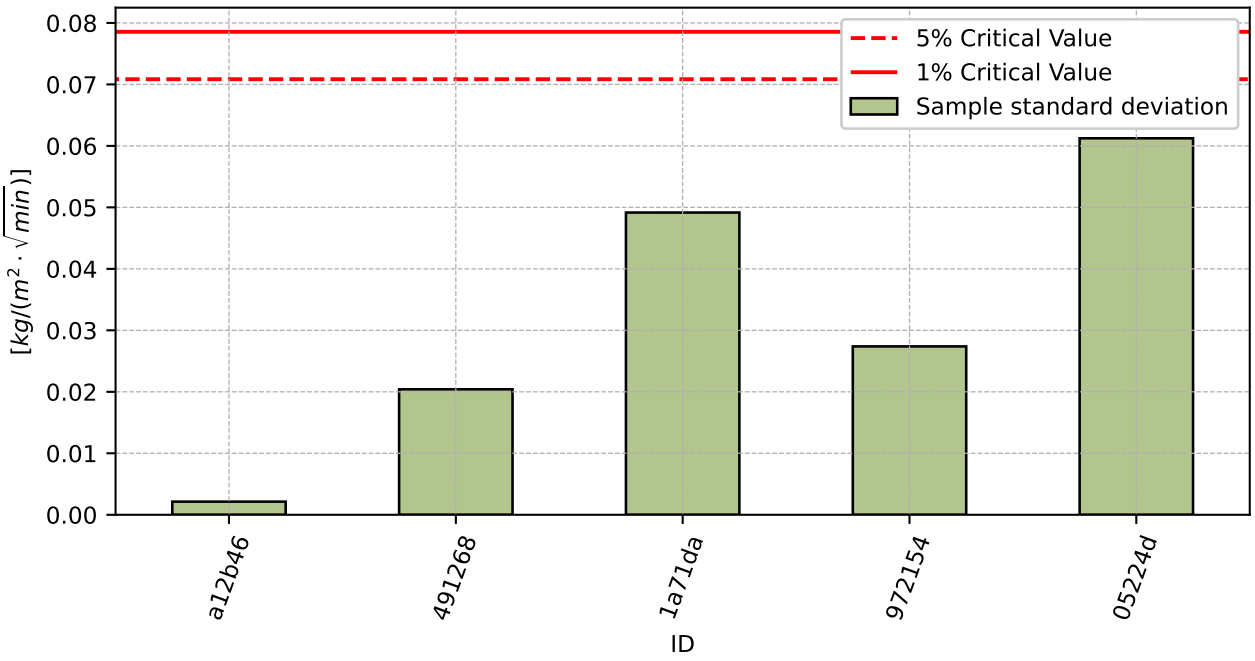

Figure 122: **Cochran's test** - sample standard deviations

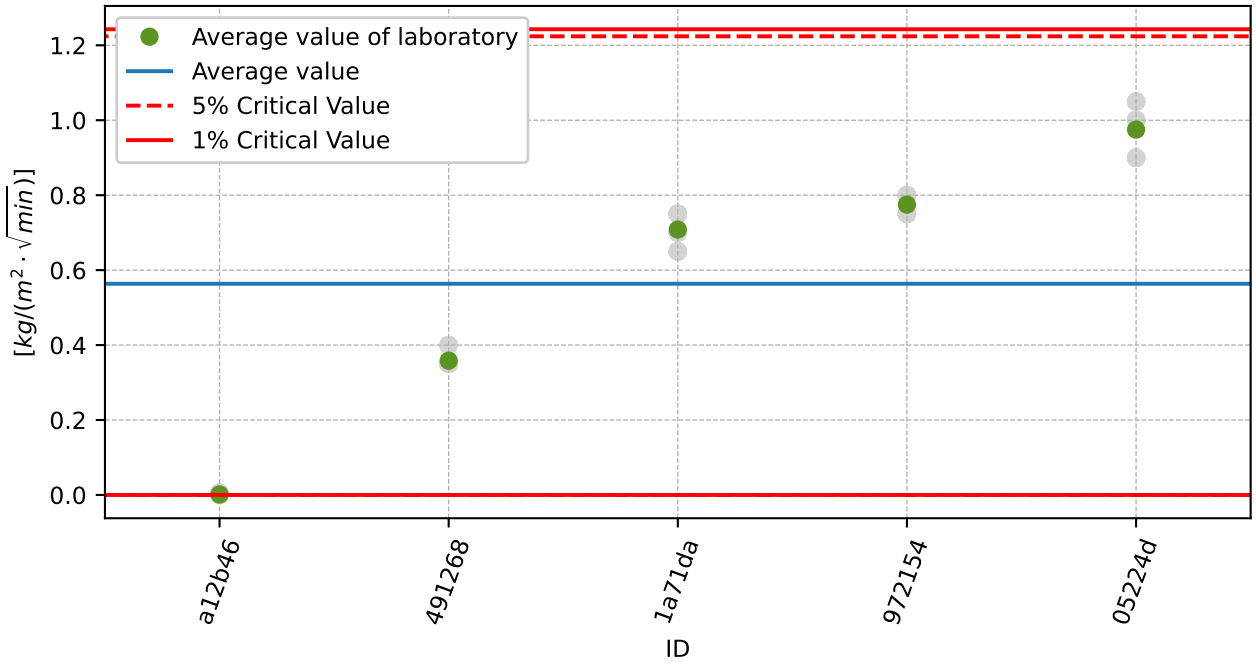

Figure 123: **Grubbs' test** - average values

16.3 Mandel's Statistics

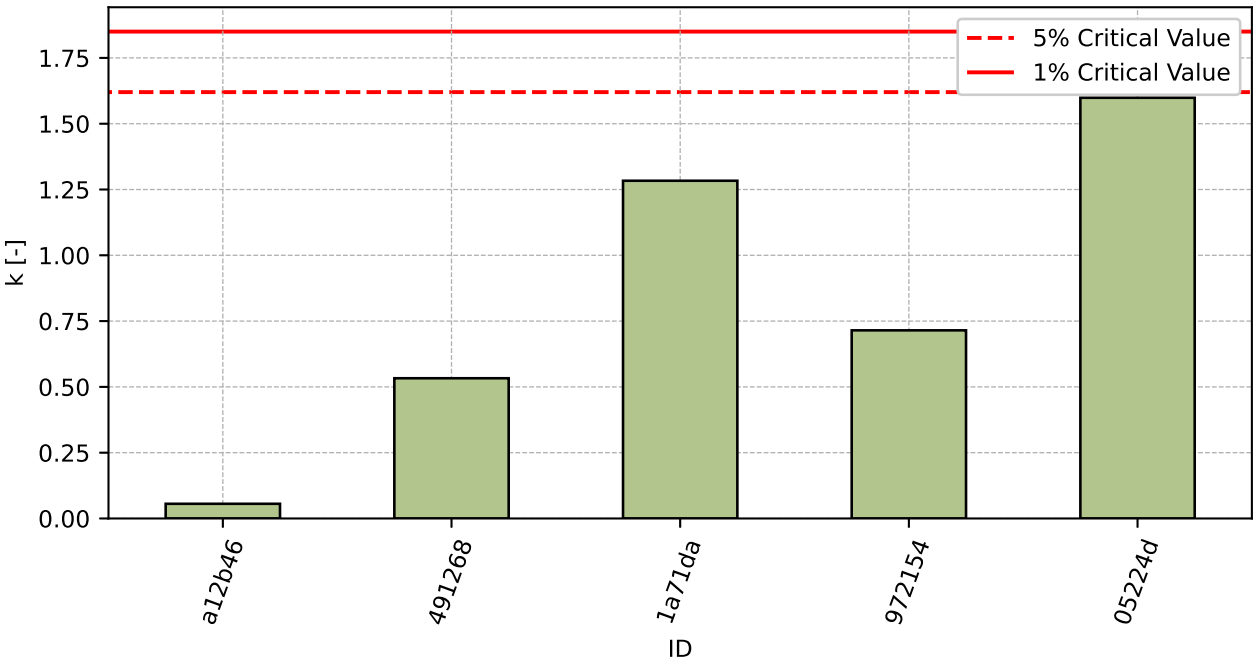

Figure 124: Intralaboratory Consistency Statistic

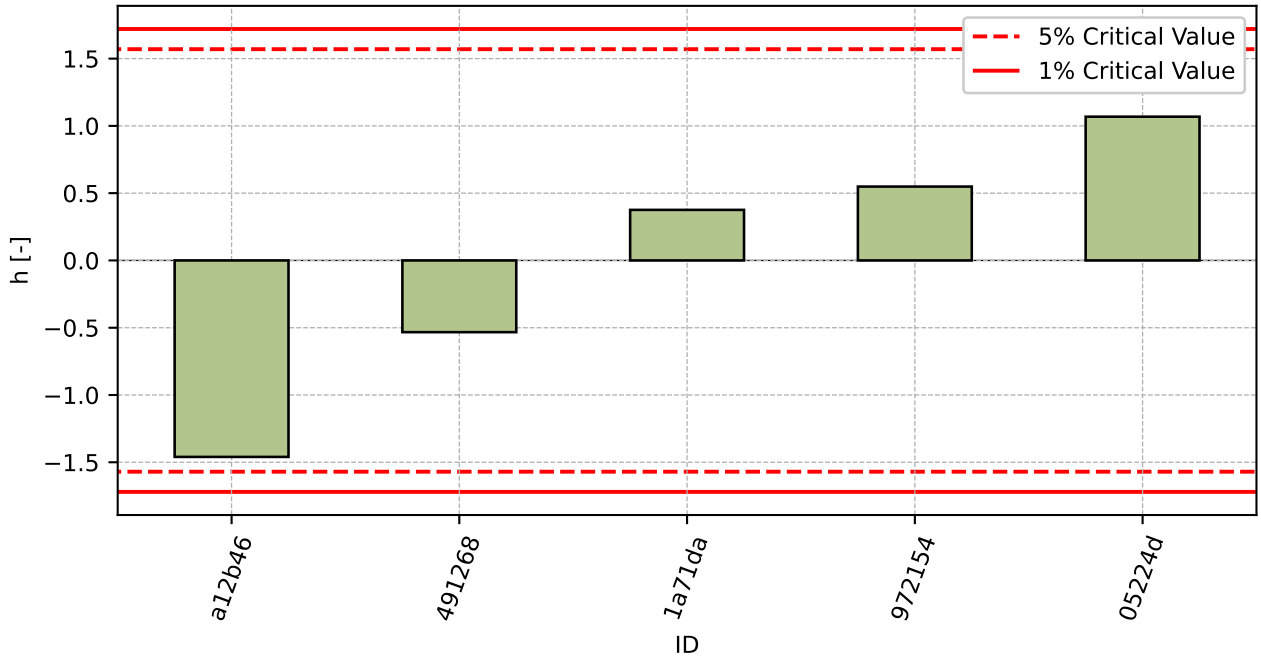

Figure 125: Interlaboratory Consistency Statistic

16.4 Descriptive statistics

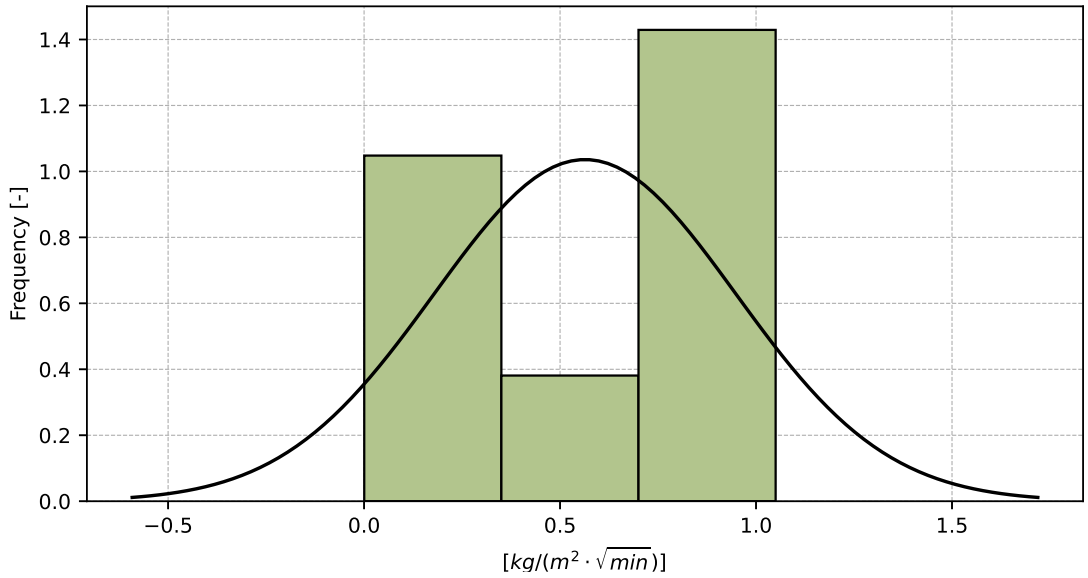

Figure 126: Histogram of all test results

Table 44: Descriptive statistics

Characteristics	[kg/(m²√min)]
Average value – $\bar{x}$	0.564
Sample standard deviation – s	0.3851
Asigned value – x^*	0.586
Robust standard deviation – s^*	0.3497
Measurement uncertainty of asigned value – u_X	0.1955
p-value of normality test	0.075 [-]
Interlaboratory standard deviation – s_L	0.3848
Repeatability standard deviation – s_r	0.0383
Reproducibility standard deviation – s_R	0.3867
Repeatability – r	0.107
Reproducibility – R	1.083

16.5 Evaluation of Performance Statistics

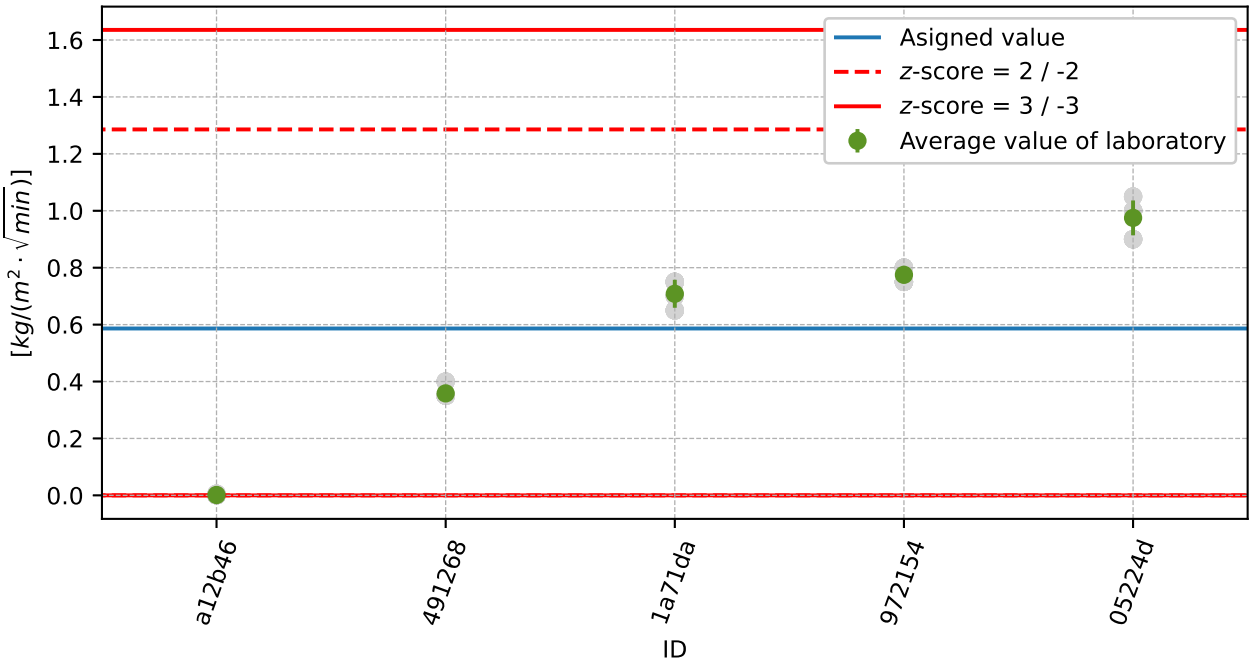

Figure 127: Average values and sample standard deviations

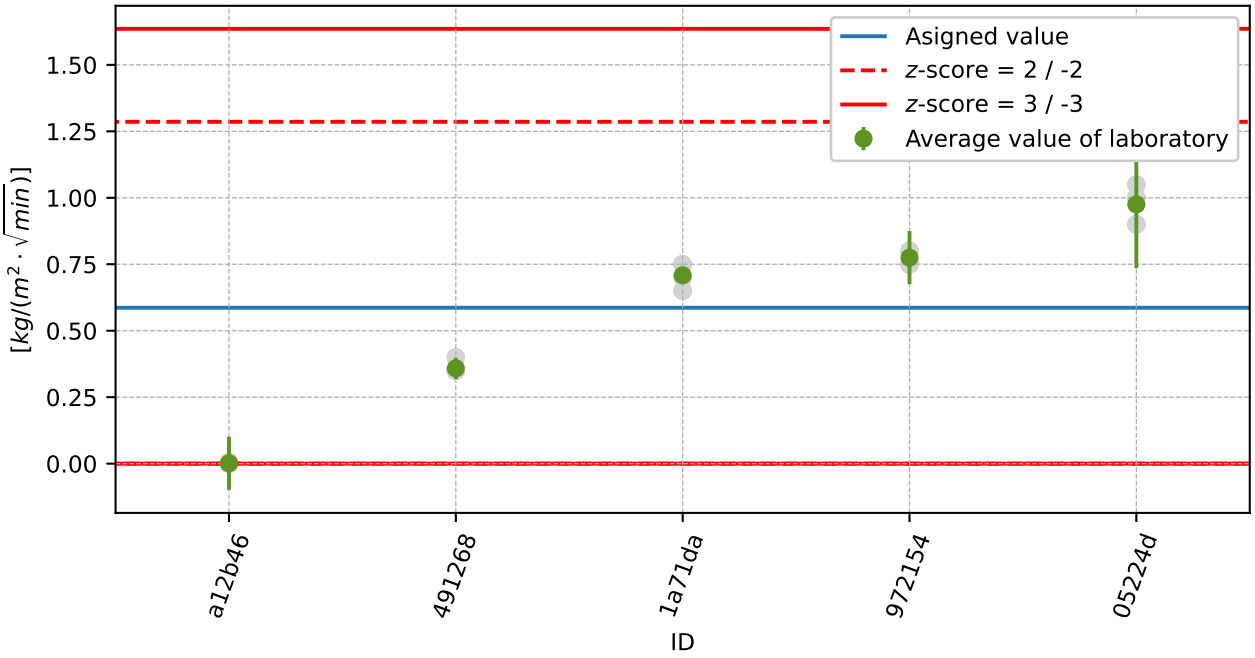

Figure 128: Average values and extended uncertainties of measurement

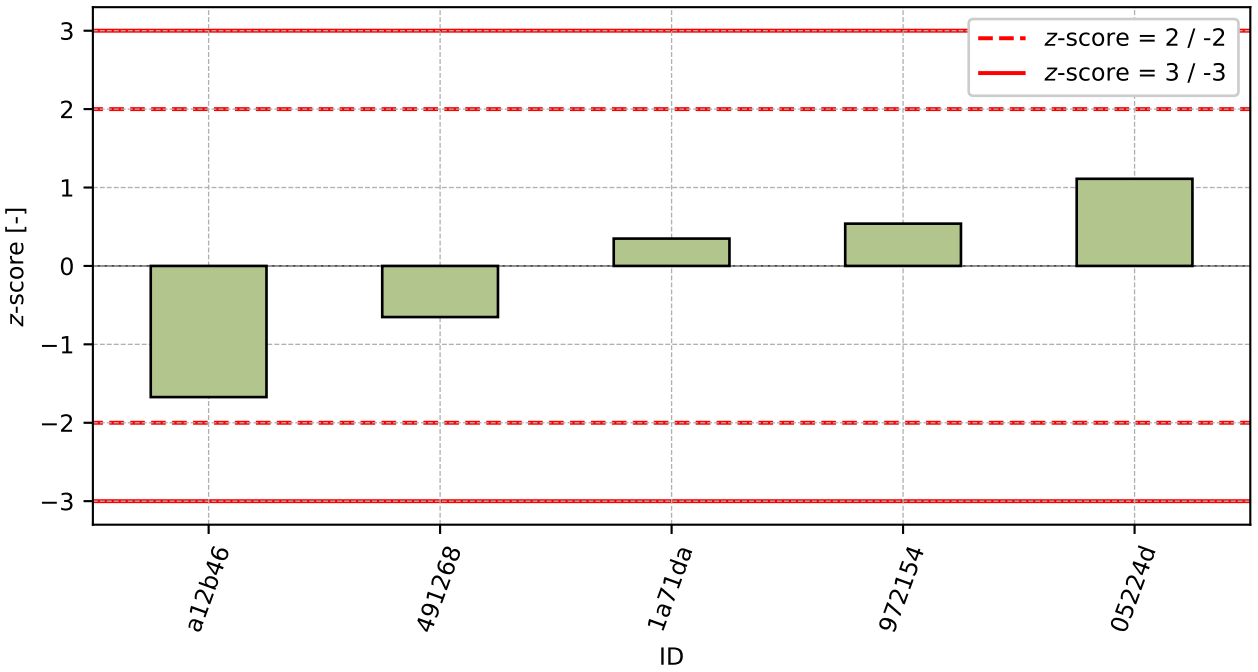

Figure 129: z-score

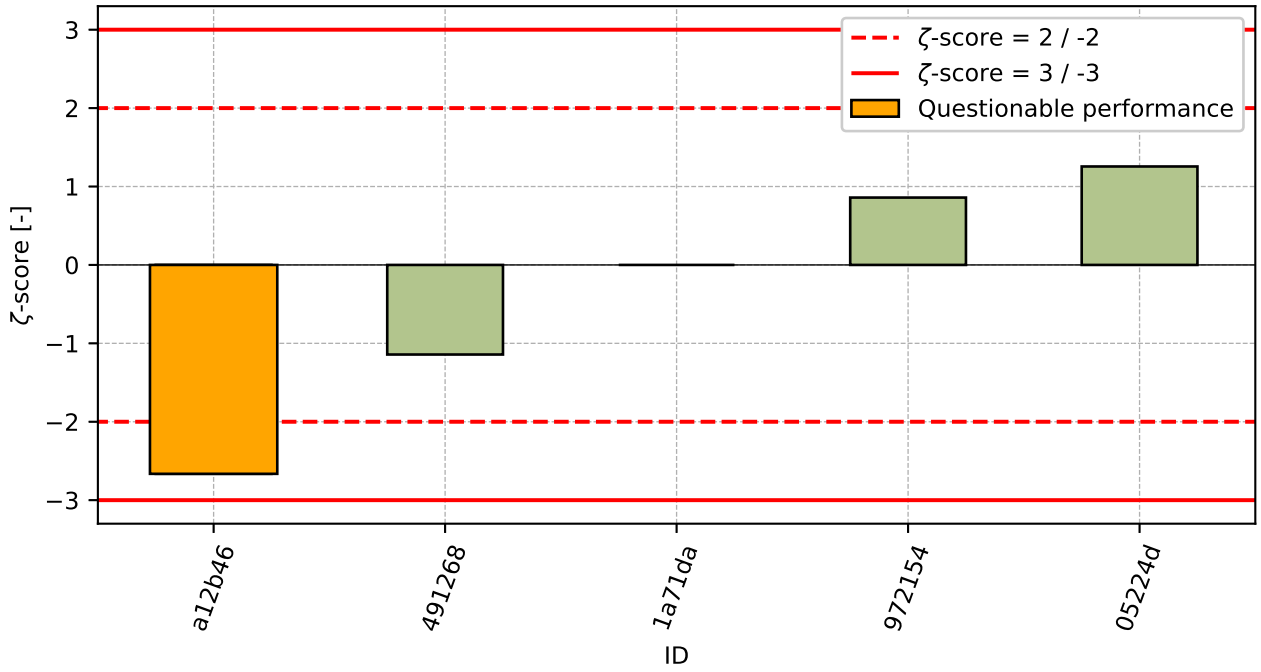

Figure 130: ζ-score

Table 45: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a12b46	-1.67	-2.66
491268	-0.65	-1.14
1a71da	0.35	-
972154	0.54	0.86
05224d	1.11	1.26

17 Appendix – EN 1015-19 – Water vapor flow

17.1 Test results

Table 46: 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 [kg/(m^2 · s · Pa)·$^{-10}$]			u_X [kg/(m^2 · s · Pa)·$^{-10}$]	$\bar{x}$ [kg/(m^2 · s · Pa)·$^{-10}$]	s_0 [kg/(m^2 · s · Pa)·$^{-10}$]	V_X [%]
05224d	0.39	0.45	0.31	0.1	0.38	0.07	18.32
a12b46	0.7	0.47	0.6	-	0.59	0.117	19.88
972154	7.9	8.8	8.4	-	8.37	0.451	5.39
c70061	7.75	9.1	9.16	0.65	8.67	0.797	9.2
736c97	10.5	9.99	10.4	1.36	10.3	0.27	2.62
1a71da	15.9	25.7	19.6	-	20.4	4.949	24.26

17.2 The Numerical Procedure for Determining Outliers

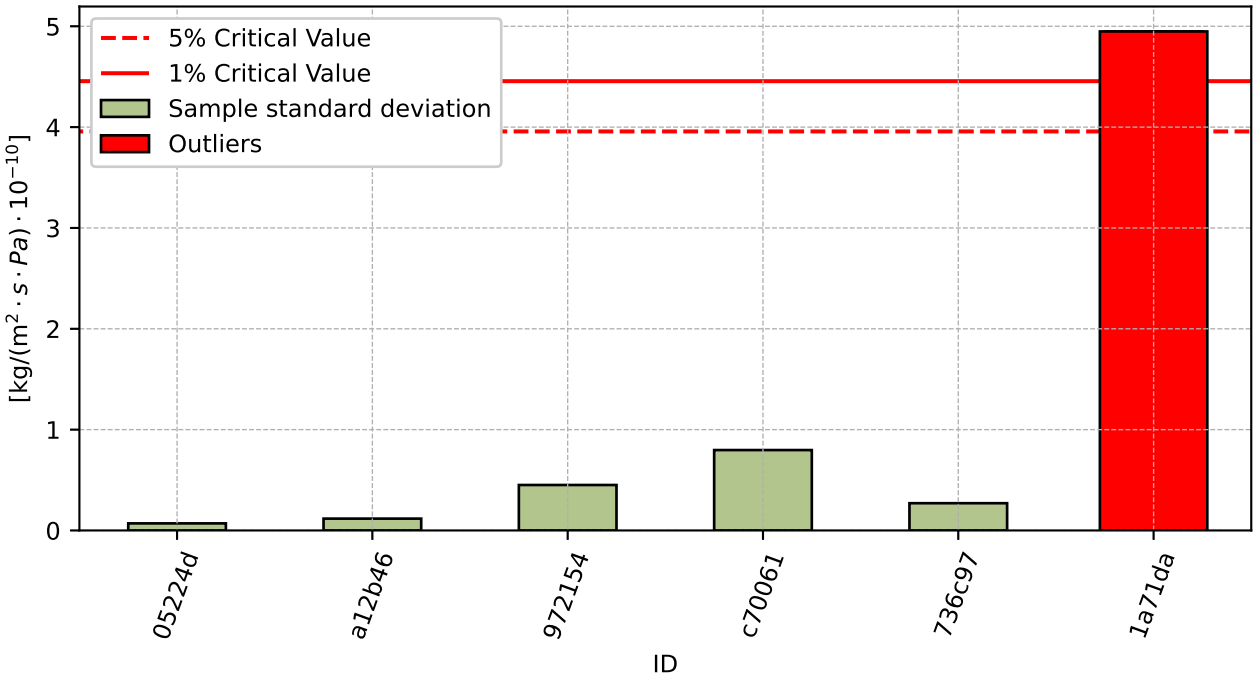

Figure 131: **Cochran's test** - sample standard deviations

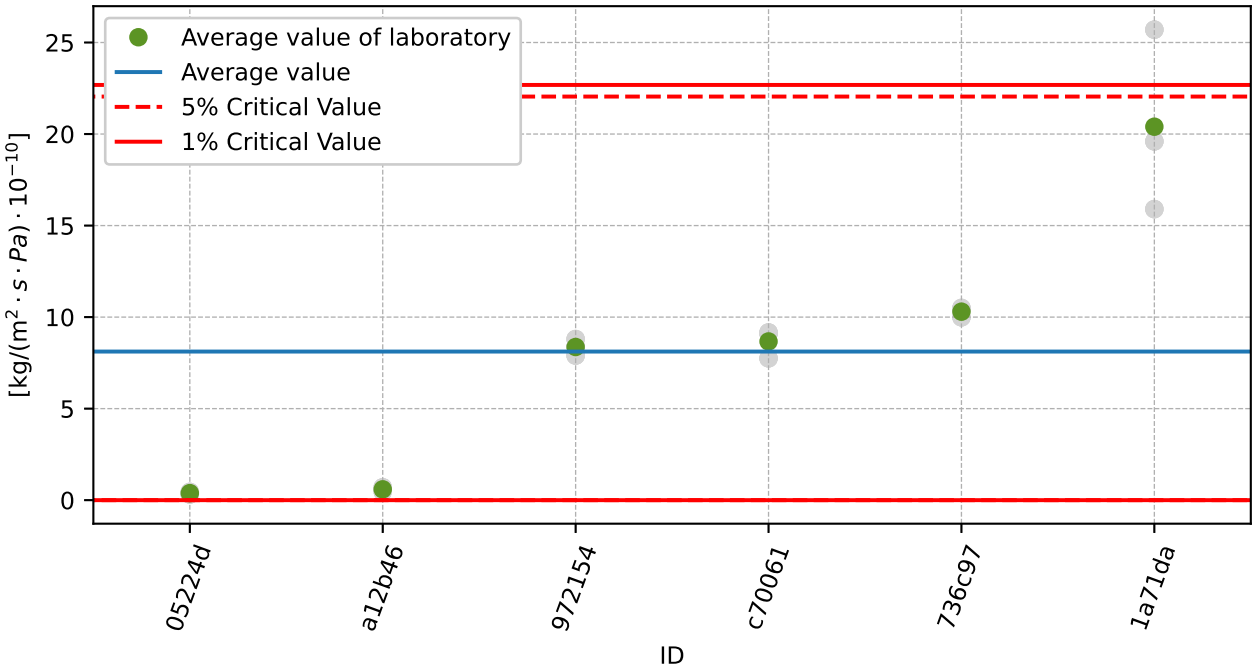

Figure 132: **Grubbs' test** - average values

17.3 Mandel's Statistics

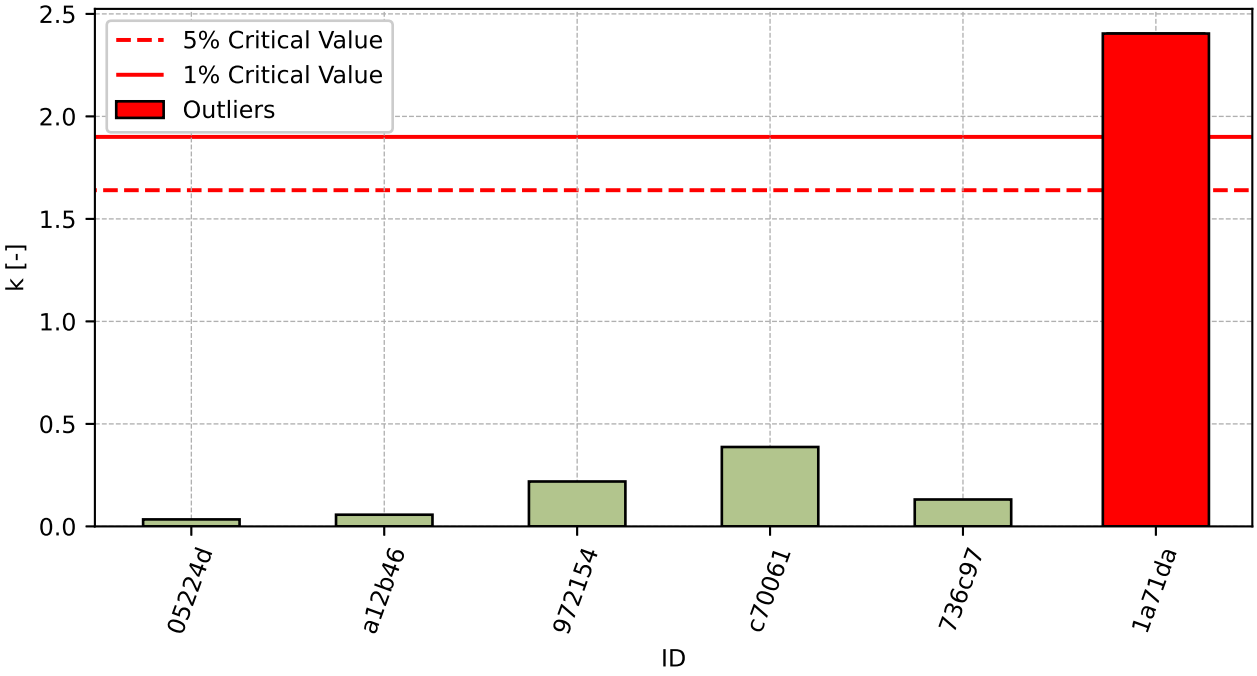

Figure 133: Intralaboratory Consistency Statistic

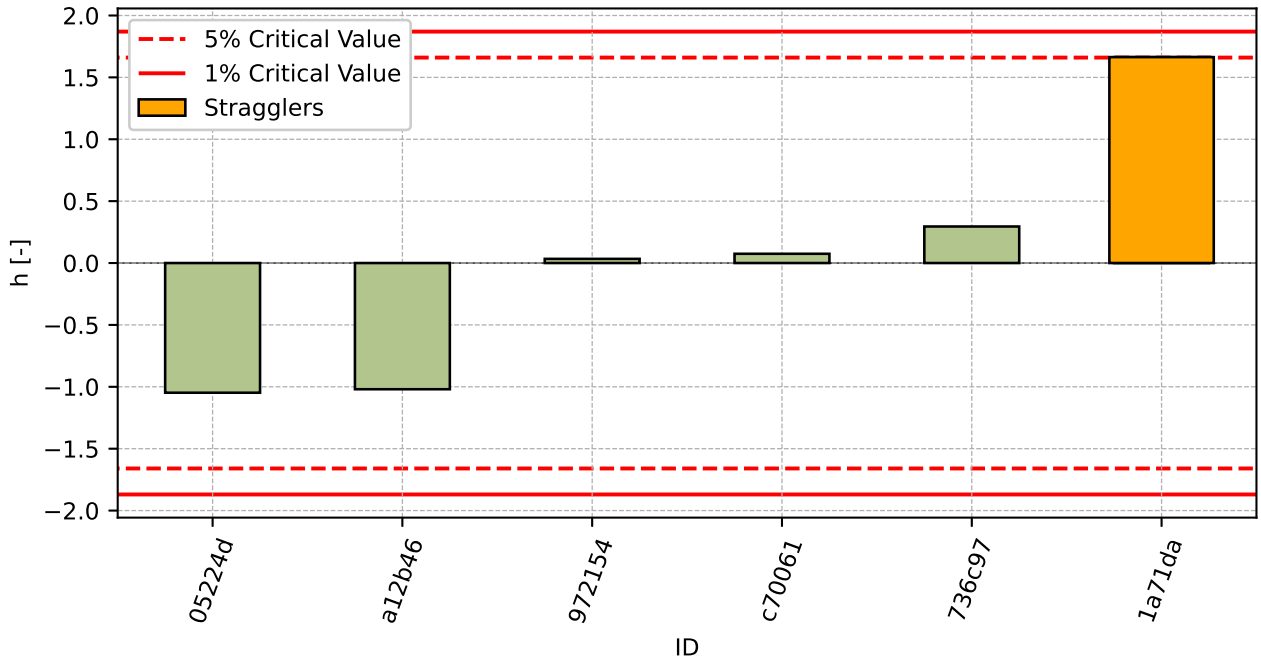

Figure 134: Interlaboratory Consistency Statistic

17.4 Descriptive statistics

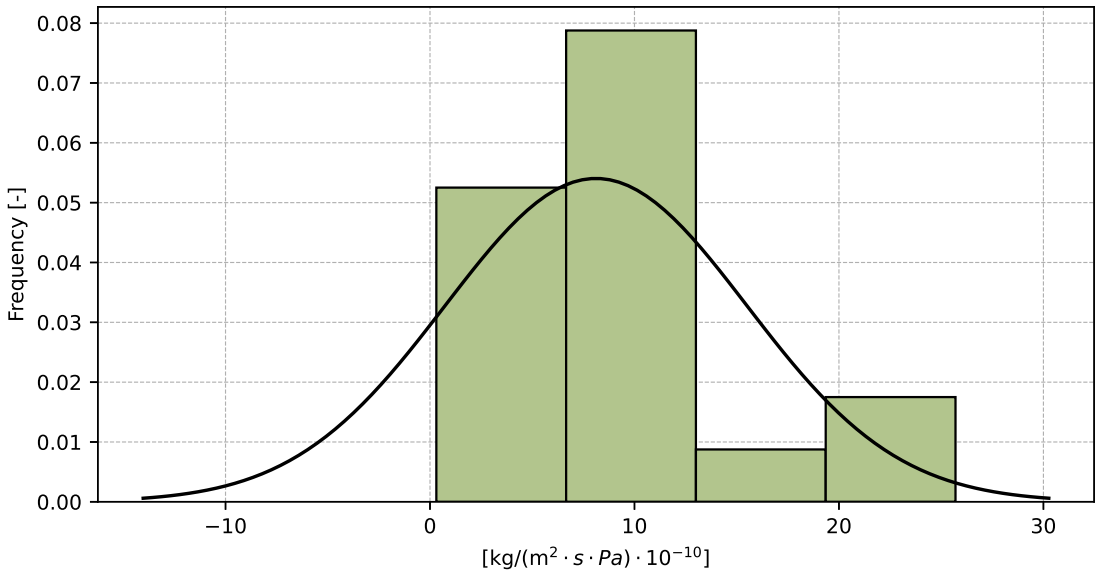

Figure 135: Histogram of all test results

Table 47: Descriptive statistics

Characteristics	[kg/(m^2 · s · Pa)·$^{-10}$]
Average value – $\bar{x}$	8.12
Sample standard deviation – s	7.382
Asigned value – x^*	8.12
Robust standard deviation – s^*	7.641
Measurement uncertainty of asigned value – u_X	3.899
p-value of normality test	0.171 [-]
Interlaboratory standard deviation – s_L	7.285
Repeatability standard deviation – s_r	2.058
Reproducibility standard deviation – s_R	7.571
Repeatability – r	5.76
Reproducibility – R	21.2

17.5 Evaluation of Performance Statistics

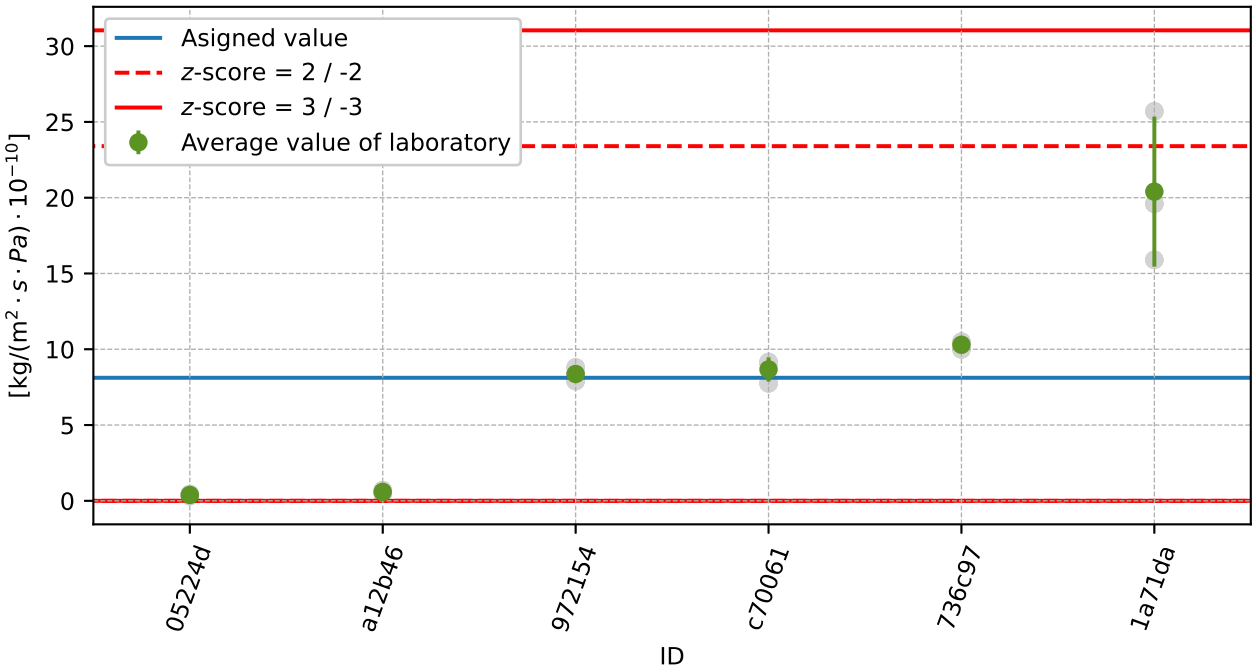

Figure 136: Average values and sample standard deviations

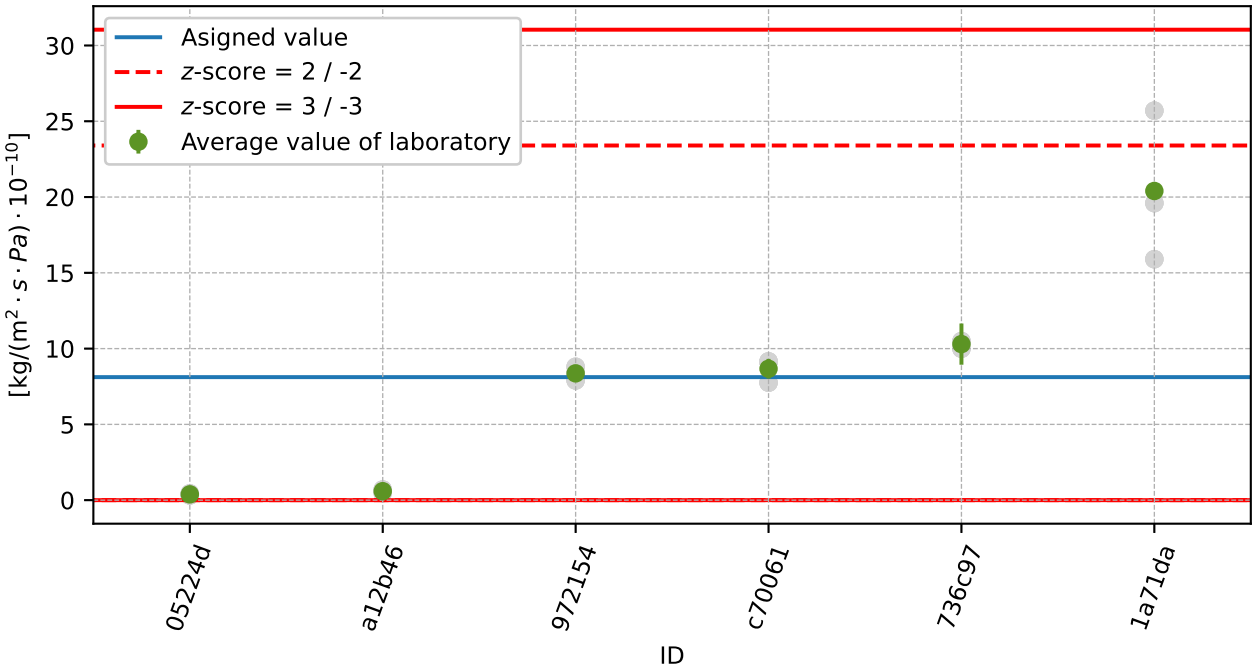

Figure 137: Average values and extended uncertainties of measurement

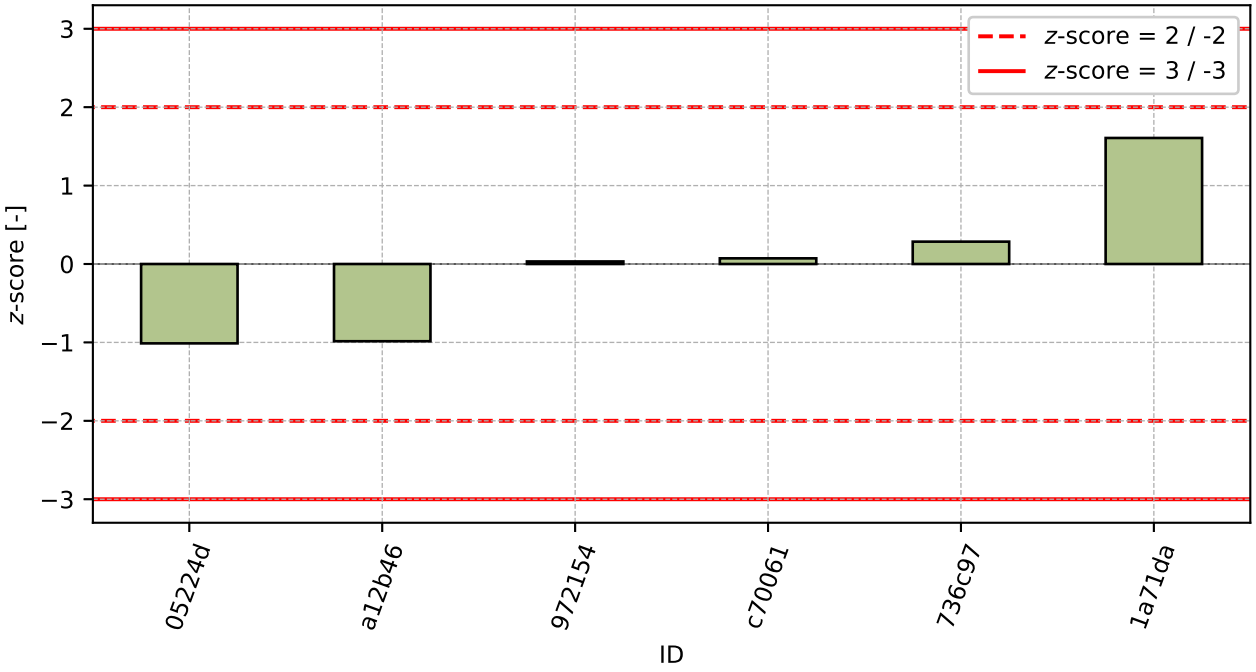

Figure 138: z-score

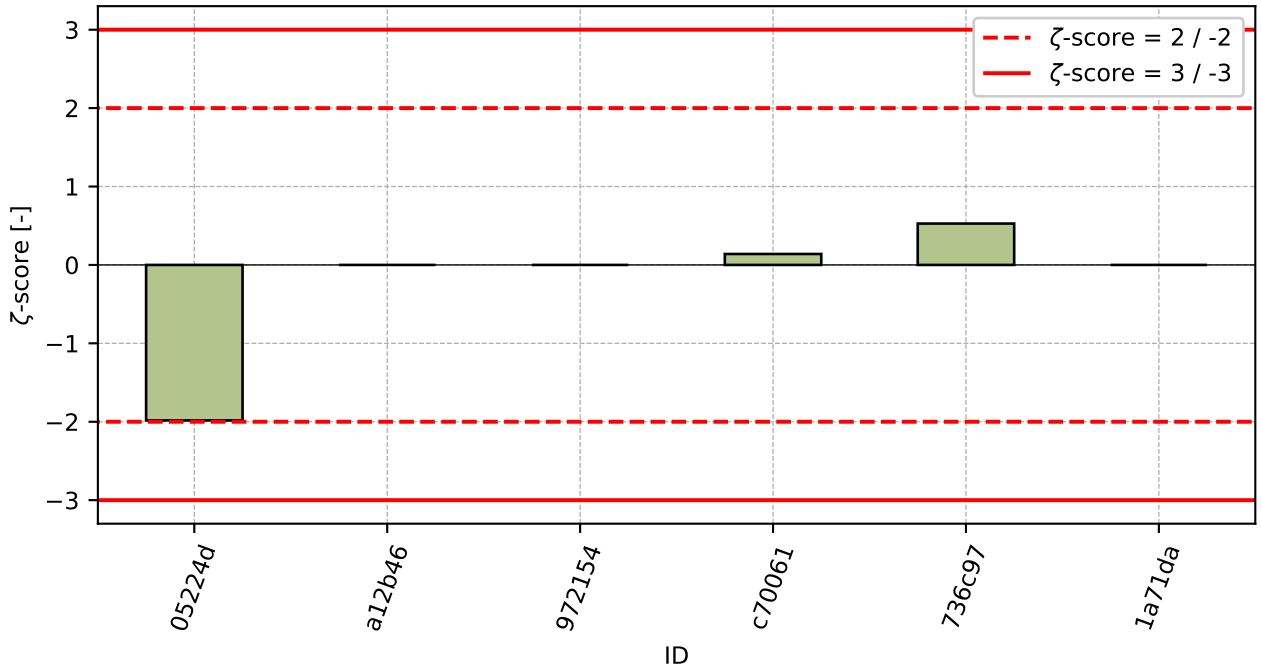

Figure 139: ζ-score

Table 48: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
05224d	-1.01	-1.98
a12b46	-0.99	-
972154	0.03	-
c70061	0.07	0.14
736c97	0.29	0.53
1a71da	1.61	-

18 Appendix – EN 13892-2 – Determination of flexural and compressive strength

18.1 Flexural Strength

18.1.1 Test results

Table 49: 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/mm^2]			u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
3f4460	3.5	3.5	3.7	0.2	3.57	0.115	3.24
a12b46	5.81	6.04	5.42	0.2	5.76	0.313	5.44
8be574	6.18	6.35	6.2	0.32	6.24	0.093	1.49
972154	7.25	7.15	6.75	0.7	7.05	0.265	3.75
6d1fa4	8.15	8.1	8.0	0.09	8.08	0.076	0.94
3e5b0a	9.0	8.2	8.6	1.1	8.6	0.4	4.65

18.1.2 The Numerical Procedure for Determining Outliers

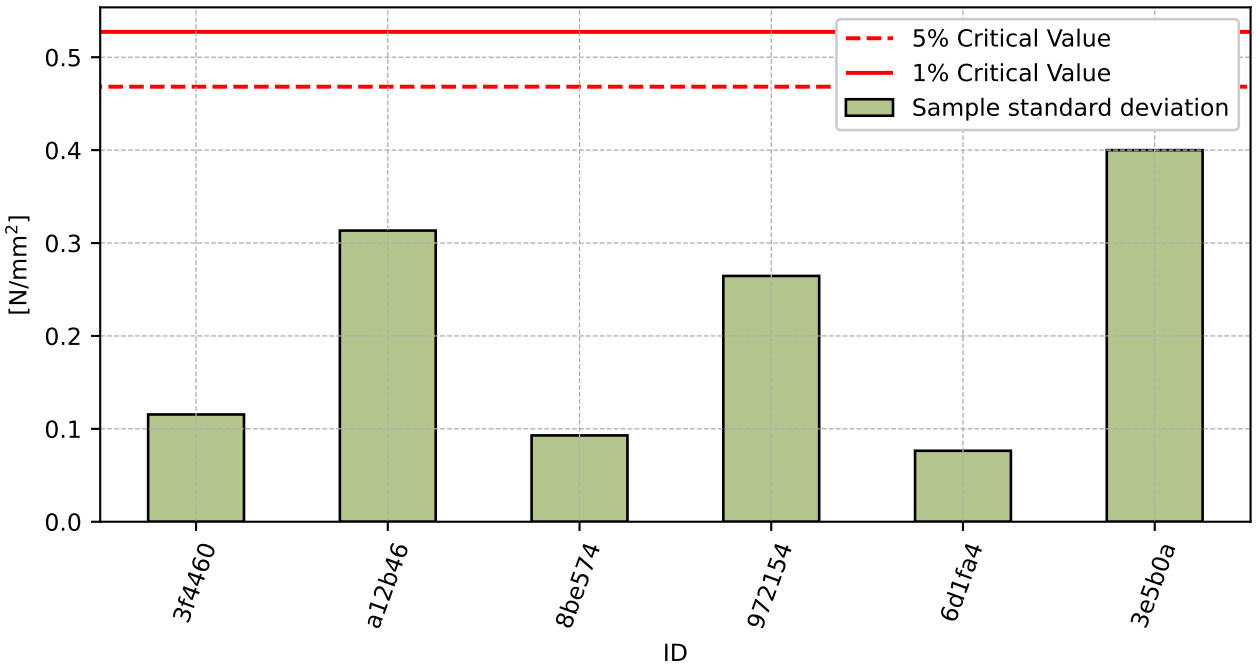

Figure 140: **Cochran's test** - sample standard deviations

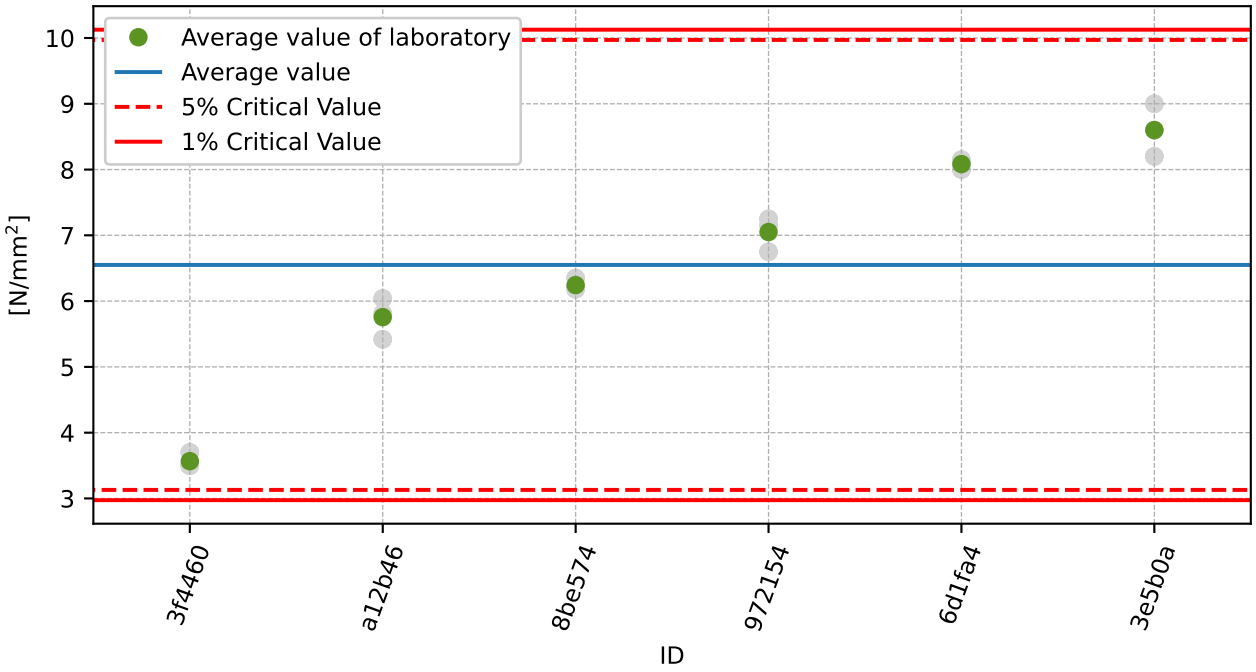

Figure 141: **Grubbs' test** - average values

18.1.3 Mandel's Statistics

Figure 142: Intralaboratory Consistency Statistic

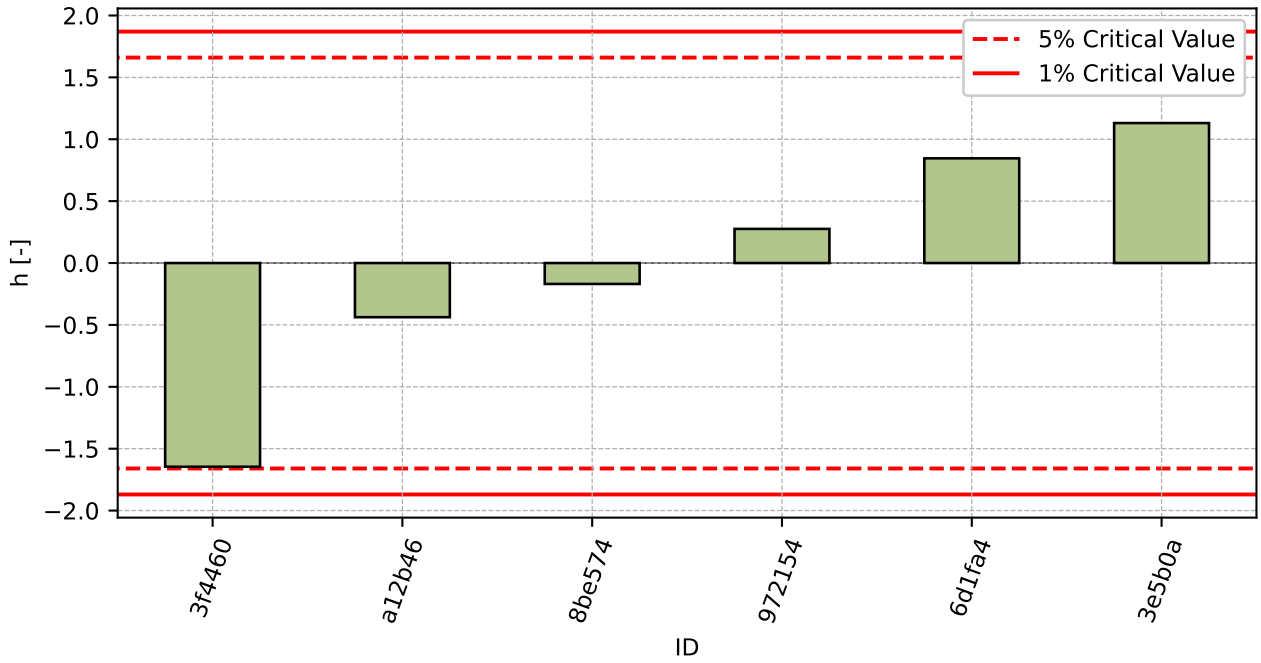

Figure 143: Interlaboratory Consistency Statistic

18.1.4 Descriptive statistics

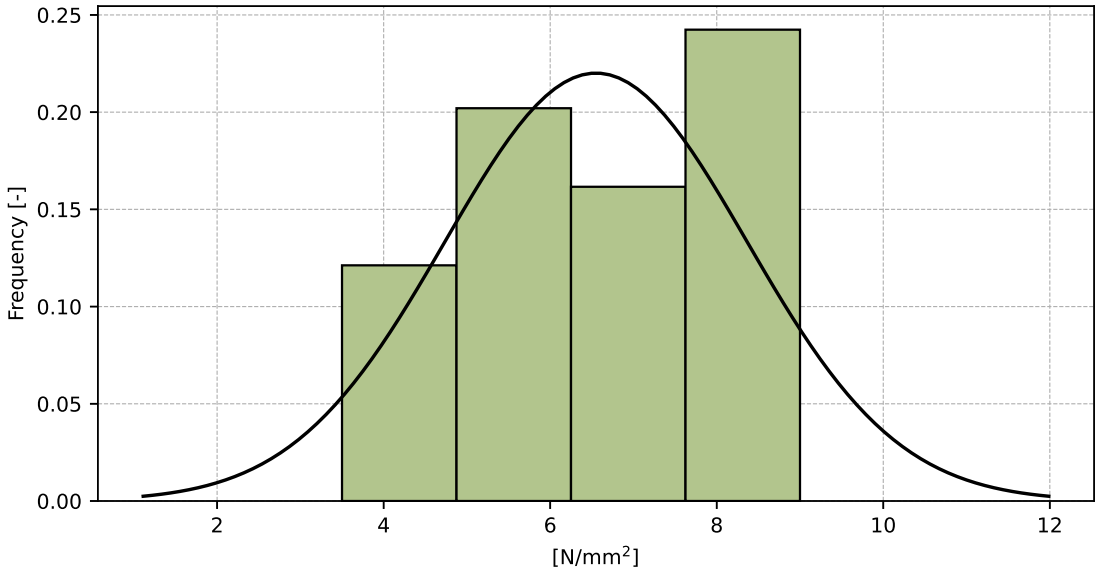

Figure 144: Histogram of all test results

Table 50: Descriptive statistics

Characteristics	[N/mm²]
Average value – $\bar{x}$	6.55
Sample standard deviation – s	1.813
Asigned value – x^*	6.63
Robust standard deviation – s^*	1.71
Measurement uncertainty of asigned value – u_X	0.873
p-value of normality test	0.515 [-]
Interlaboratory standard deviation – s_L	1.807
Repeatability standard deviation – s_r	0.244
Reproducibility standard deviation – s_R	1.823
Repeatability – r	0.68
Reproducibility – R	5.11

18.1.5 Evaluation of Performance Statistics

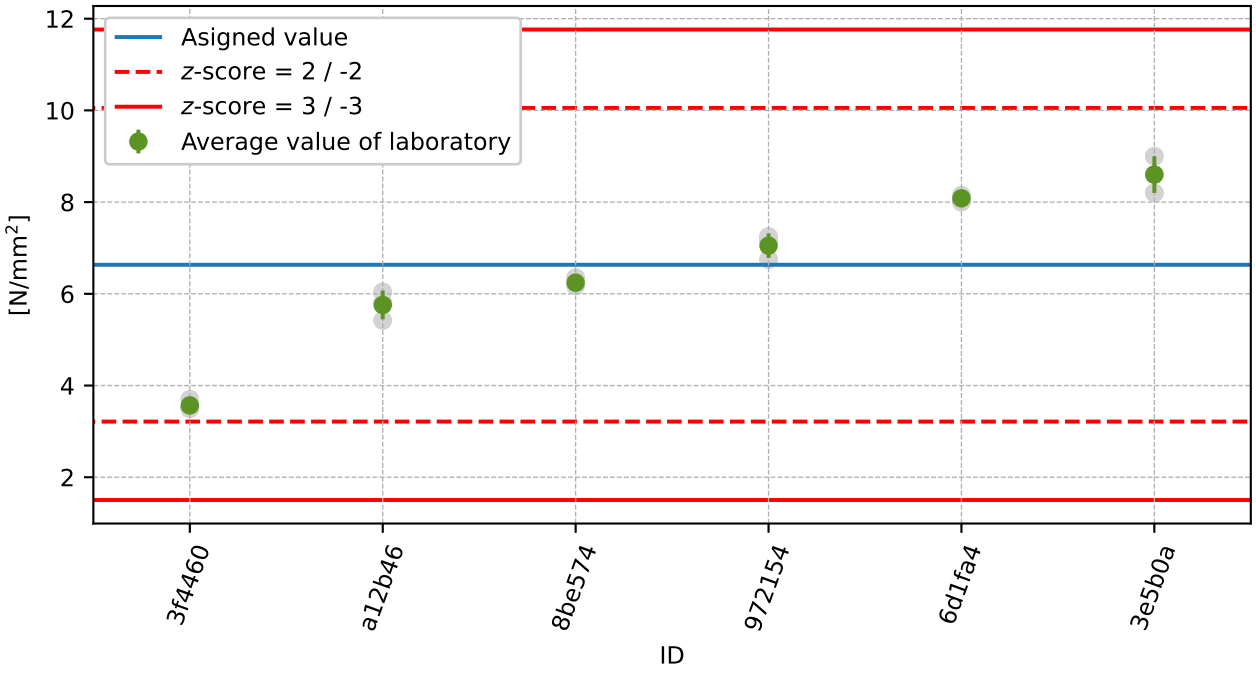

Figure 145: Average values and sample standard deviations

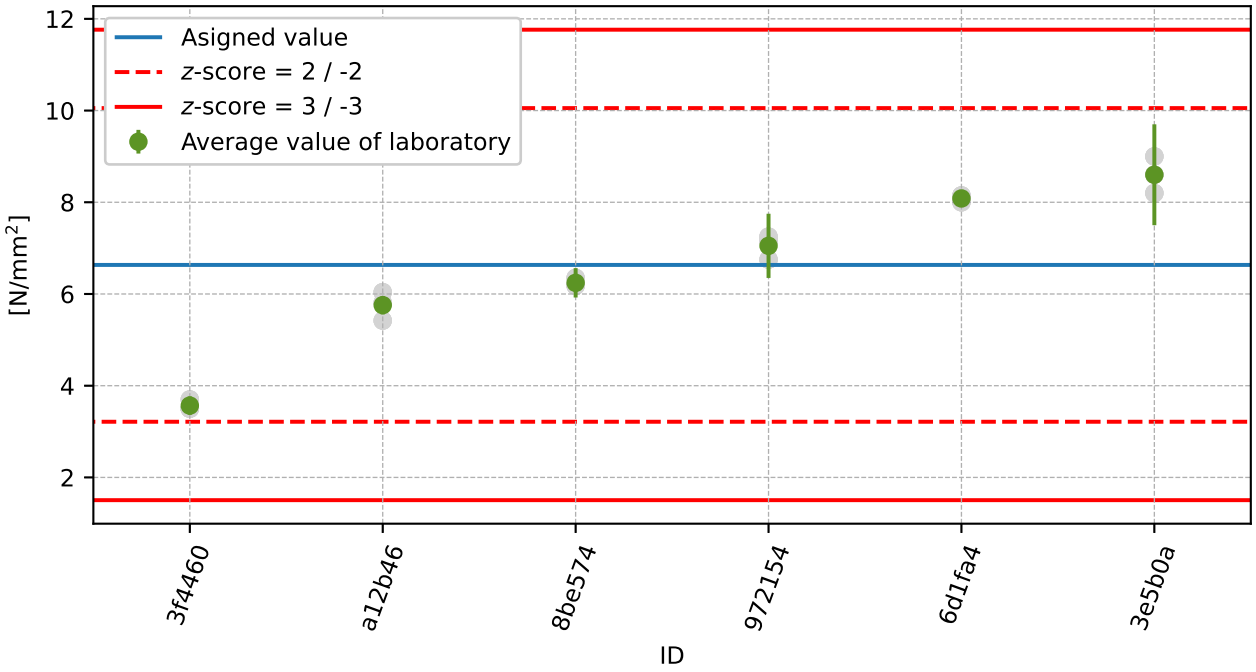

Figure 146: Average values and extended uncertainties of measurement

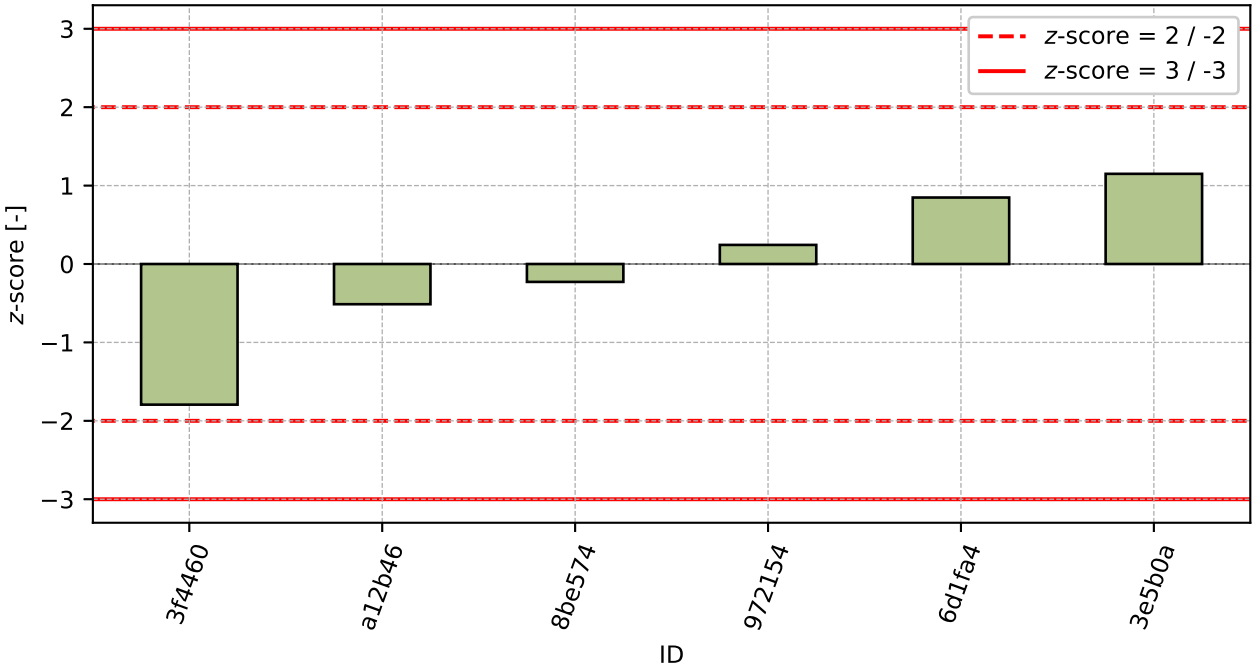

Figure 147: z-score

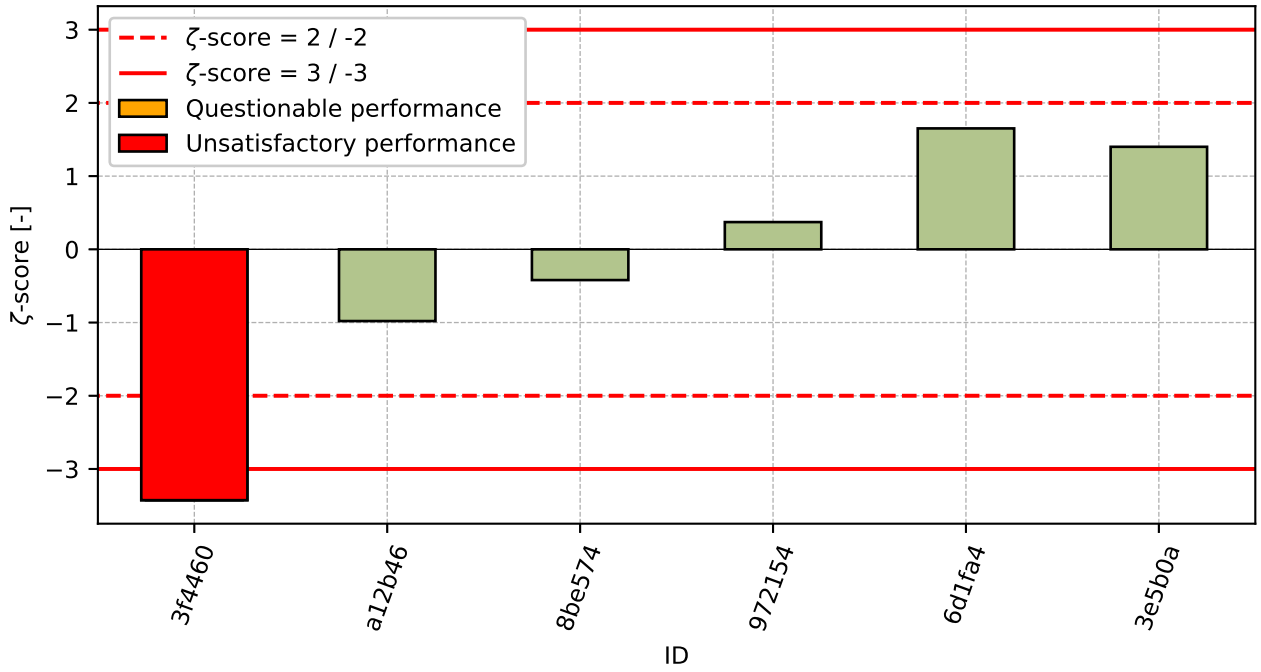

Figure 148: ζ-score

Table 51: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
3f4460	-1.79	-3.43
a12b46	-0.51	-0.98
8be574	-0.23	-0.42
972154	0.24	0.37
6d1fa4	0.85	1.65
3e5b0a	1.15	1.4

18.2 Compressive Strength

18.2.1 Test results

Table 52: 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/mm^2]						u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
3f4460	28.08	26.16	28.01	27.57	23.76	25.44	1.8	26.5	1.713	6.46
8be574	31.3	30.4	30.6	30.1	31.3	30.5	0.54	30.7	0.494	1.61
a12b46	29.0	33.5	31.8	31.87	33.2	31.6	0.3	31.83	1.596	5.01
972154	34.65	34.95	35.25	35.5	36.5	37.45	1.2	35.72	1.059	2.97
6d1fa4	35.5	35.55	35.55	36.15	36.15	36.25	0.22	35.86	0.358	1.0
3e5b0a	48.5	48.75	49.45	48.4	47.75	47.4	1.0	48.38	0.729	1.51

18.2.2 The Numerical Procedure for Determining Outliers

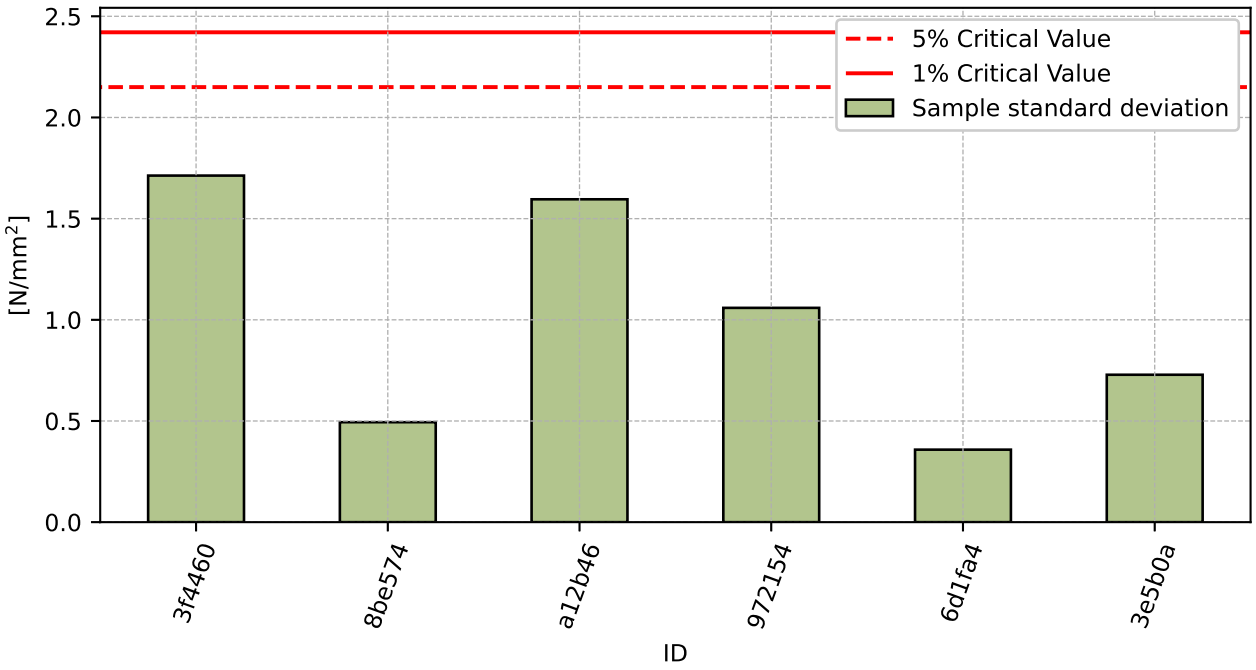

Figure 149: **Cochran's test** - sample standard deviations

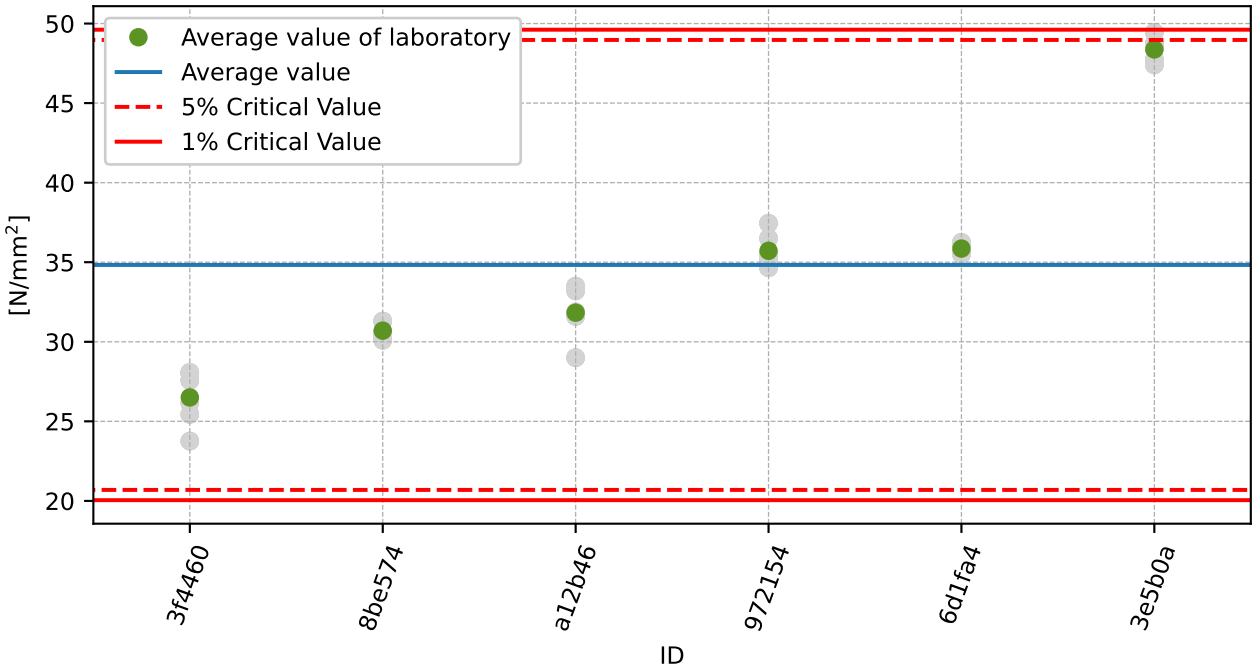

Figure 150: **Grubbs' test** - average values

18.2.3 Mandel's Statistics

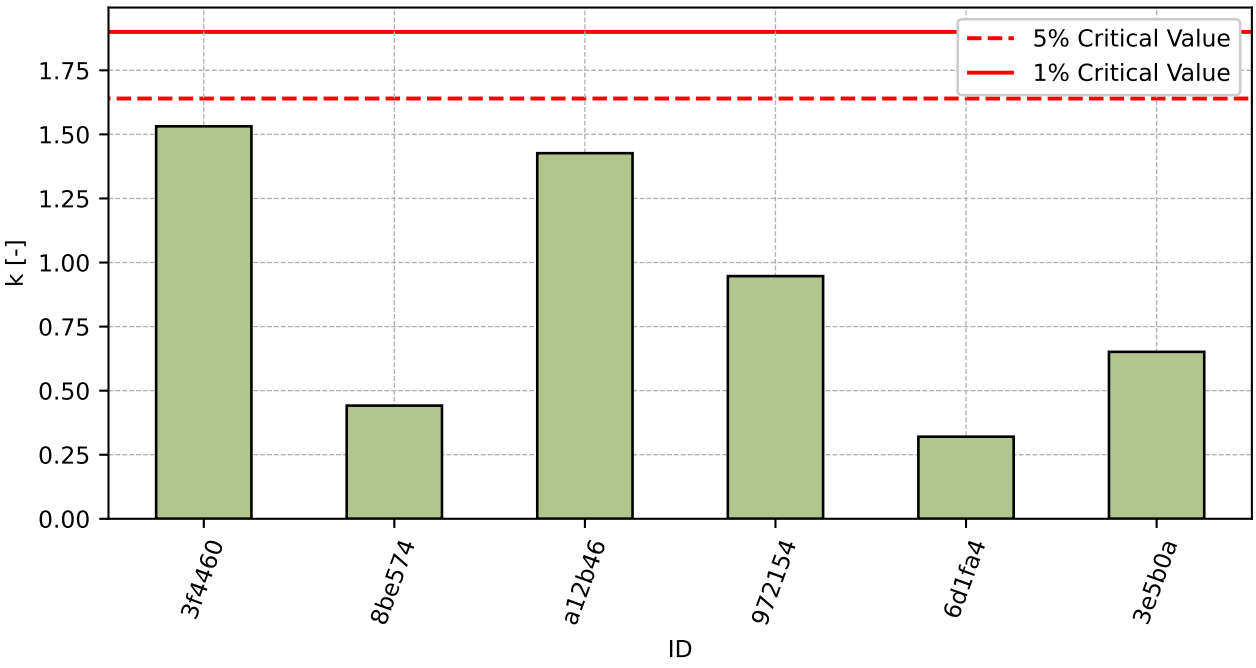

Figure 151: Intralaboratory Consistency Statistic

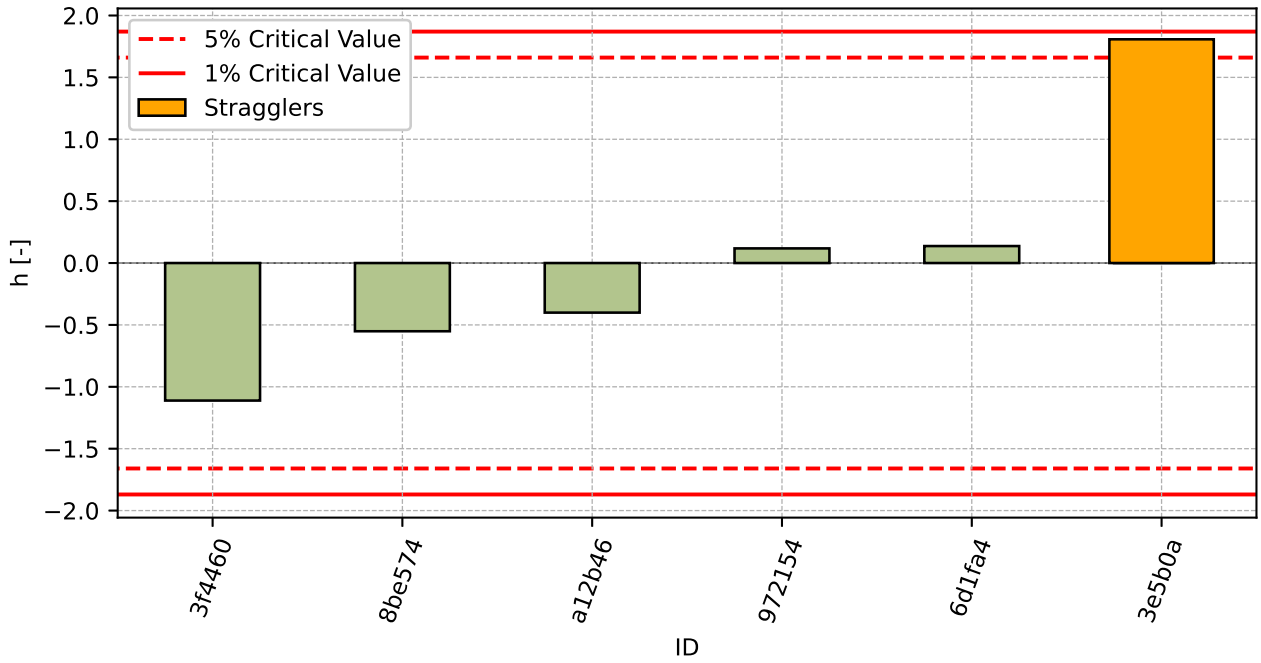

Figure 152: Interlaboratory Consistency Statistic

18.2.4 Descriptive statistics

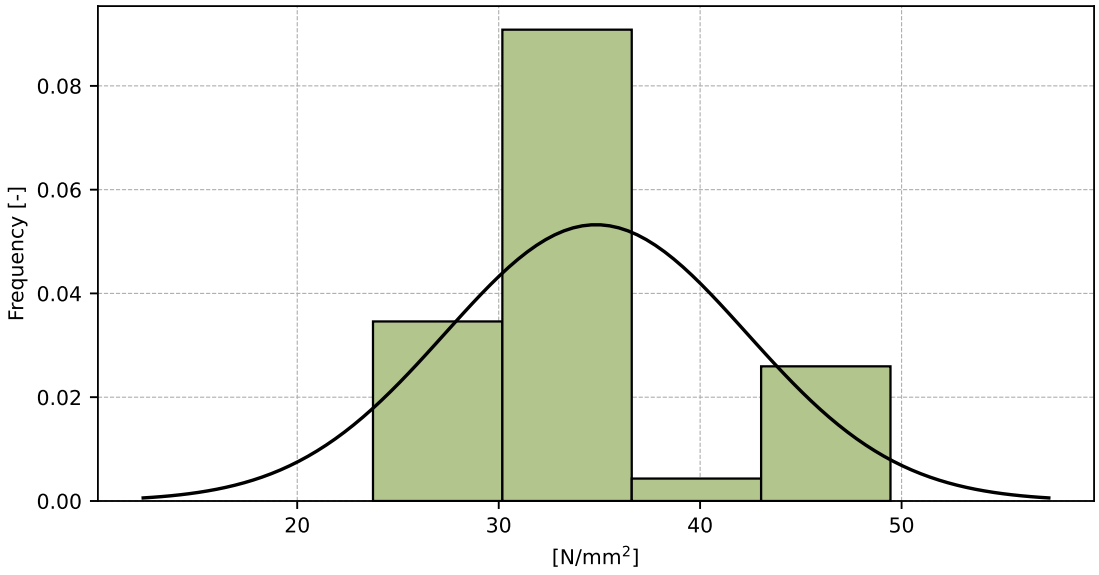

Figure 153: Histogram of all test results

Table 53: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	34.83
Sample standard deviation – s	7.493
Asigned value – x^*	35.09
Robust standard deviation – s^*	7.424
Measurement uncertainty of asigned value – u_X	3.789
p-value of normality test	0.072 [-]
Interlaboratory standard deviation – s_L	7.479
Repeatability standard deviation – s_r	1.118
Reproducibility standard deviation – s_R	7.562
Repeatability – r	3.13
Reproducibility – R	21.17

18.2.5 Evaluation of Performance Statistics

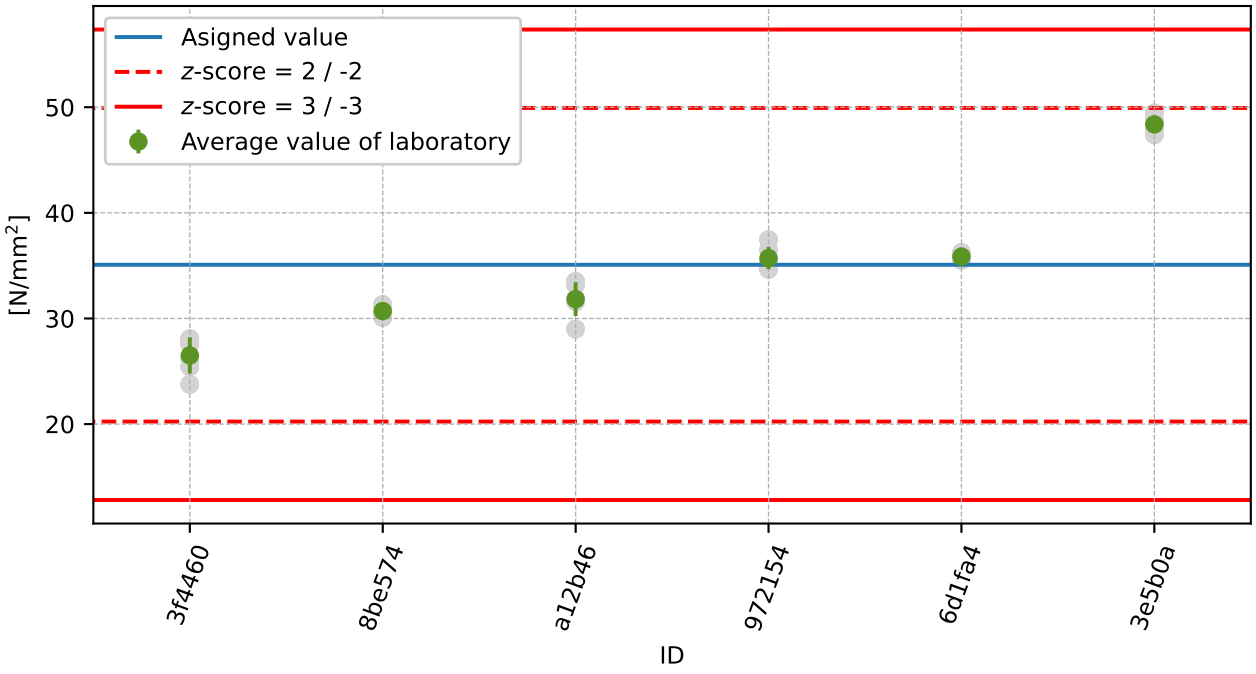

Figure 154: Average values and sample standard deviations

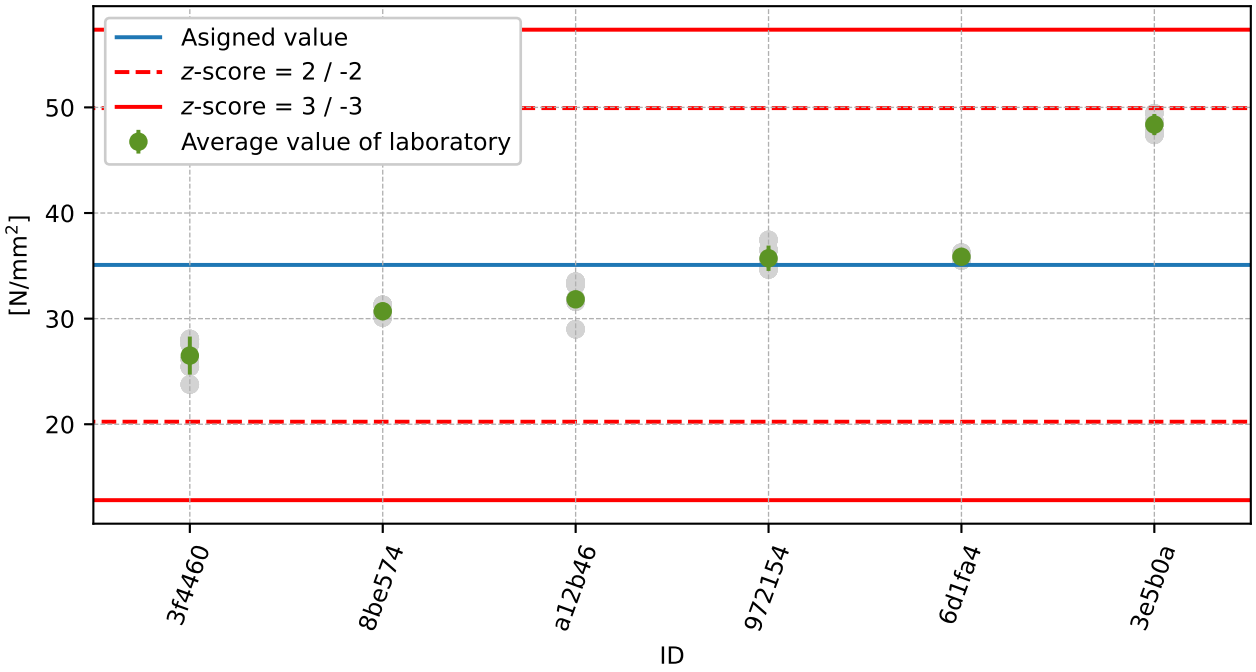

Figure 155: Average values and extended uncertainties of measurement

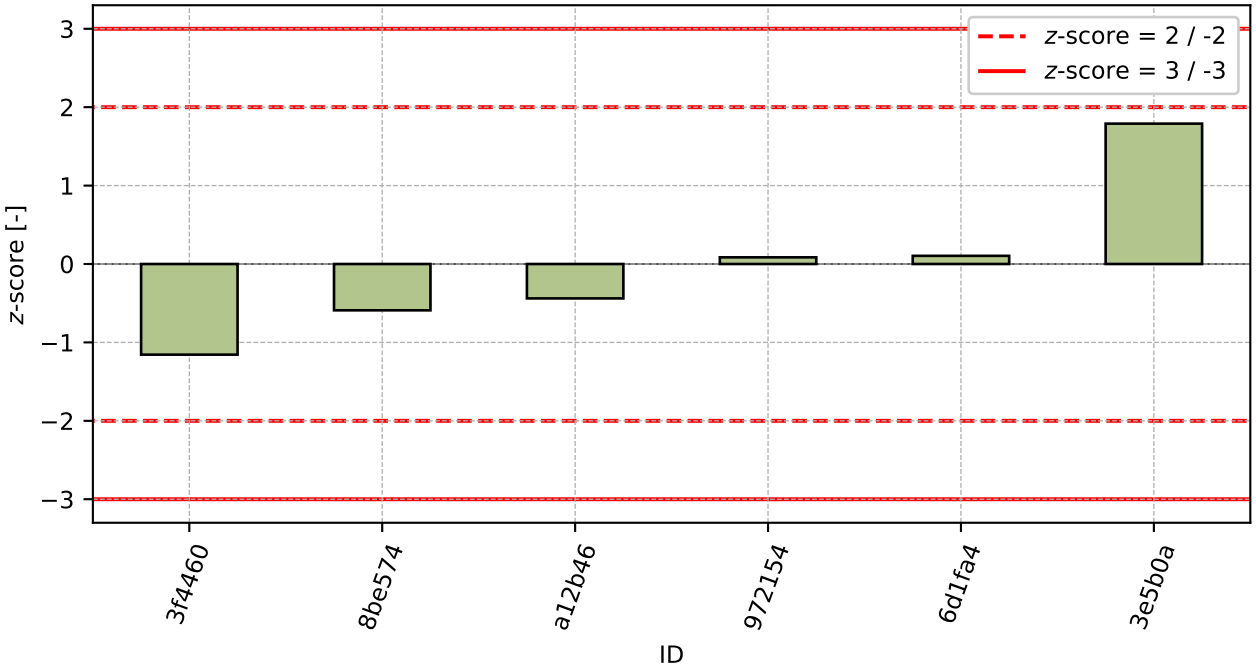

Figure 156: z-score

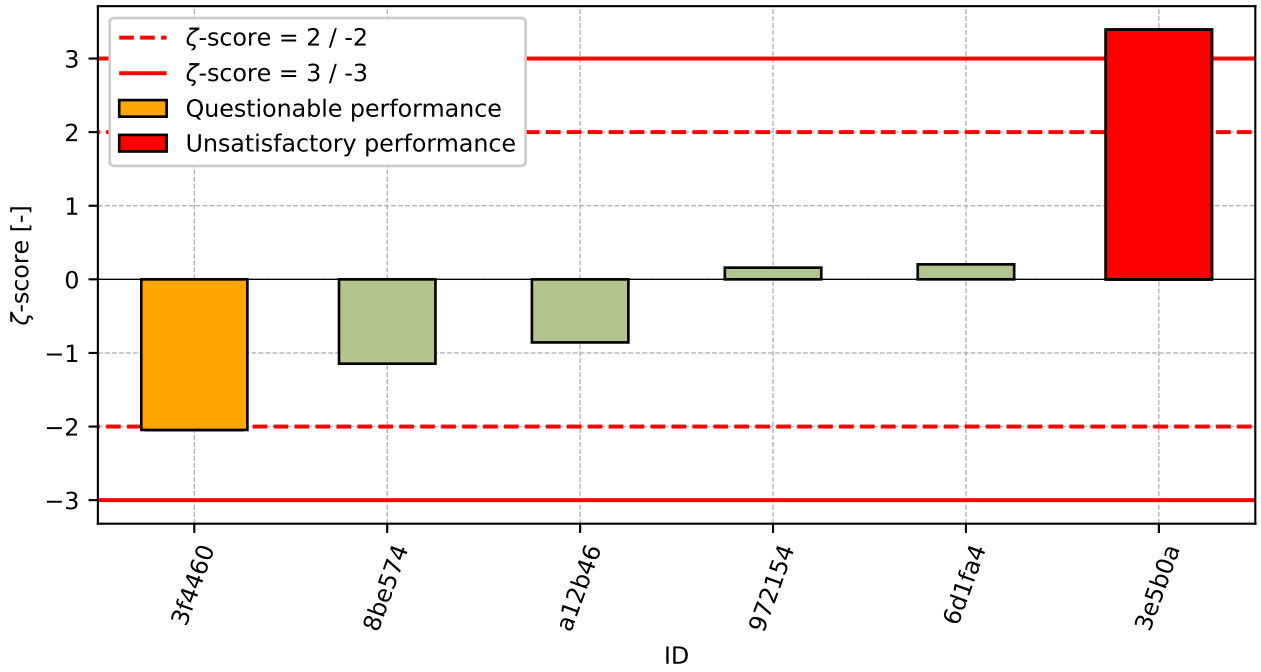

Figure 157: ζ-score

Table 54: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
3f4460	-1.16	-2.05
8be574	-0.59	-1.15
a12b46	-0.44	-0.86
972154	0.09	0.16
6d1fa4	0.1	0.2
3e5b0a	1.79	3.39

19 Appendix – EN 12004-2 (art. 8.1) – Open time

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

20 Appendix – EN 12004-2 (art. 8.2) – Slippage

20.1 Test results

Table 55: 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 [mm]			u_X [mm]	$\bar{x}$ [mm]	s_0 [mm]	V_X [%]
972154	0.04	0.02	0.04	0.06	0.03	0.012	34.64
1a71da	0.03	0.04	0.04	-	0.04	0.006	15.75
a12b46	0.11	0.19	0.15	0.01	0.15	0.04	26.67
37d0bb	0.1	0.2	0.3	0.1	0.2	0.1	50.0
8be574	0.55	0.56	0.7	0.1	0.6	0.084	13.96

20.2 The Numerical Procedure for Determining Outliers

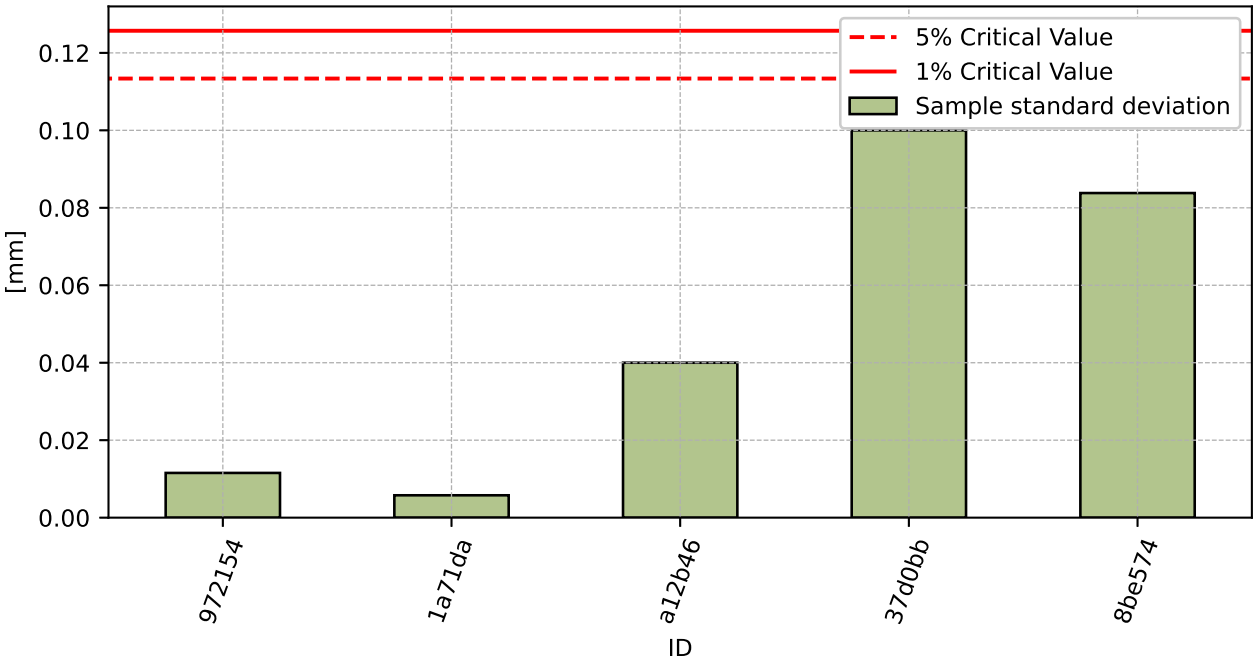

Figure 158: **Cochran's test** - sample standard deviations

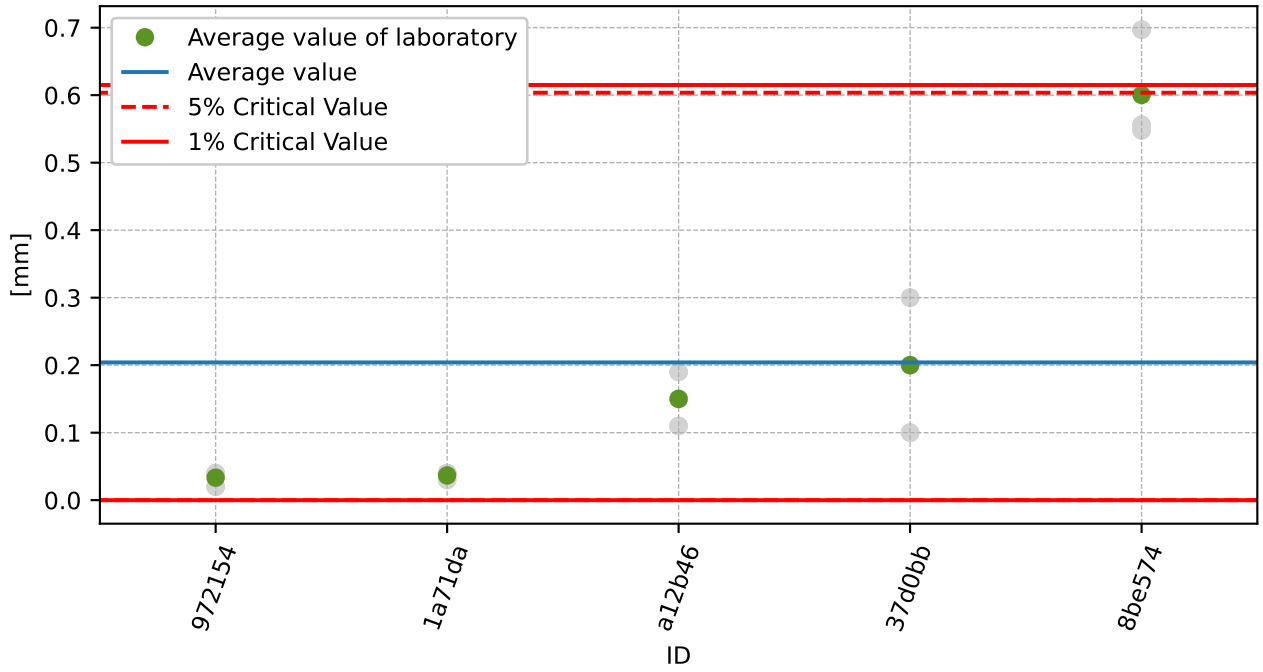

Figure 159: **Grubbs' test** - average values

20.3 Mandel's Statistics

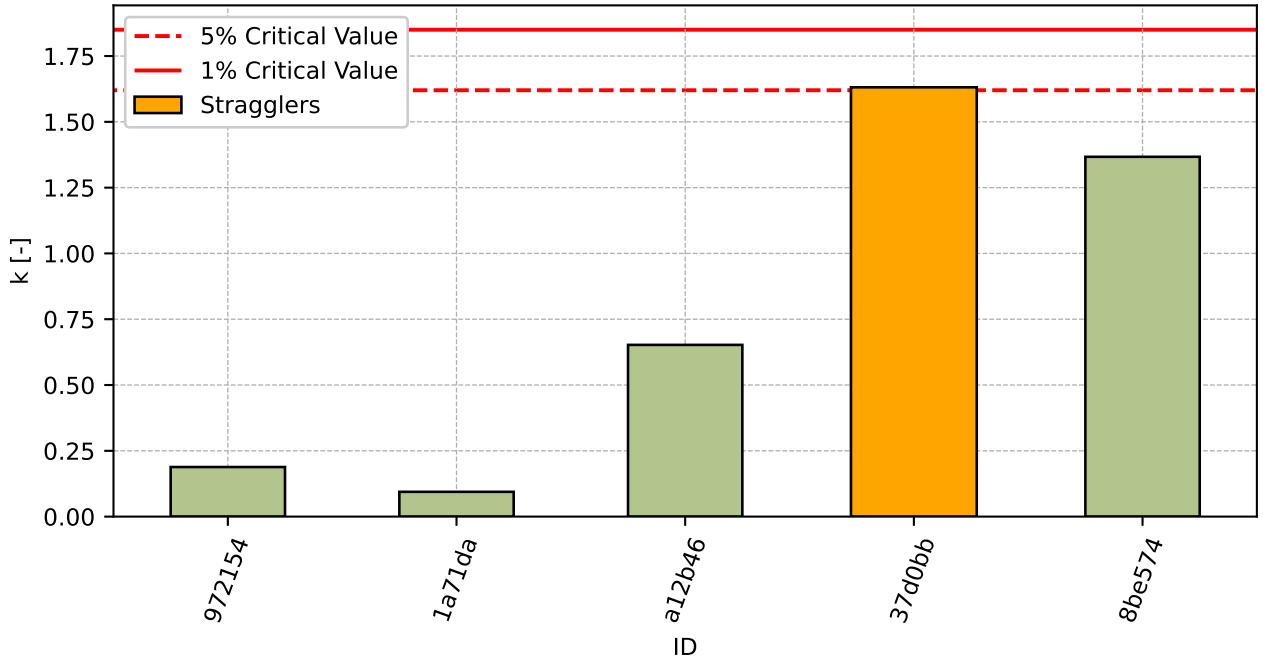

Figure 160: Intralaboratory Consistency Statistic

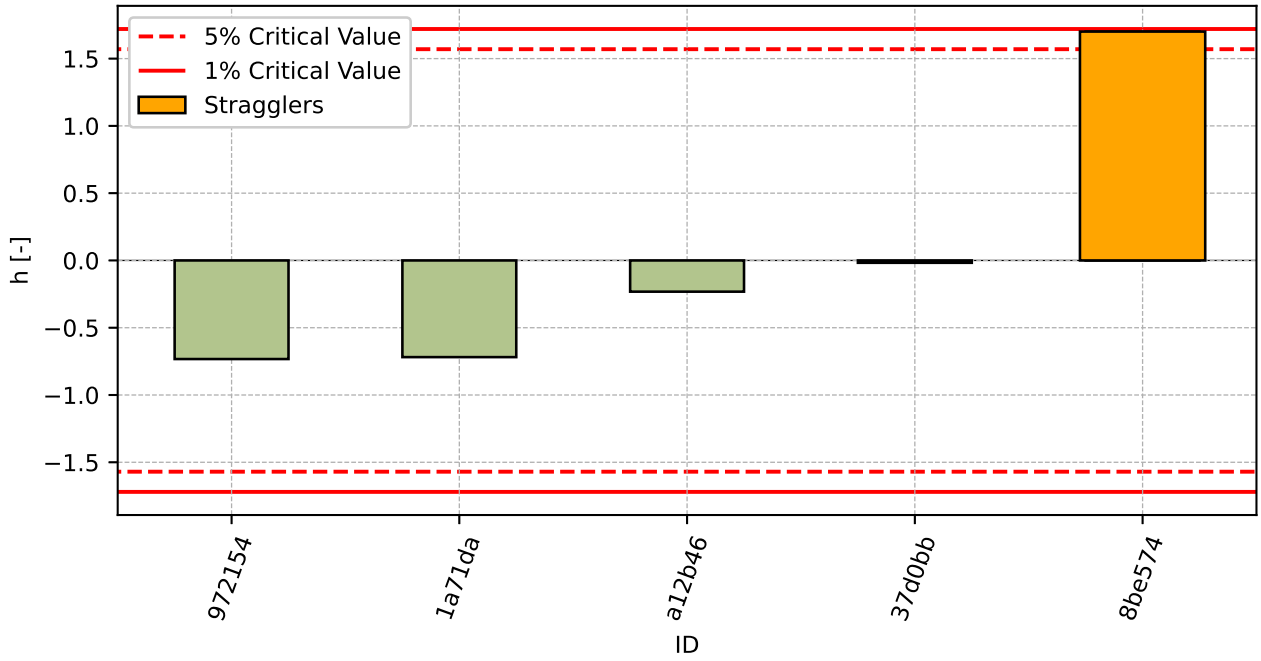

Figure 161: Interlaboratory Consistency Statistic

20.4 Descriptive statistics

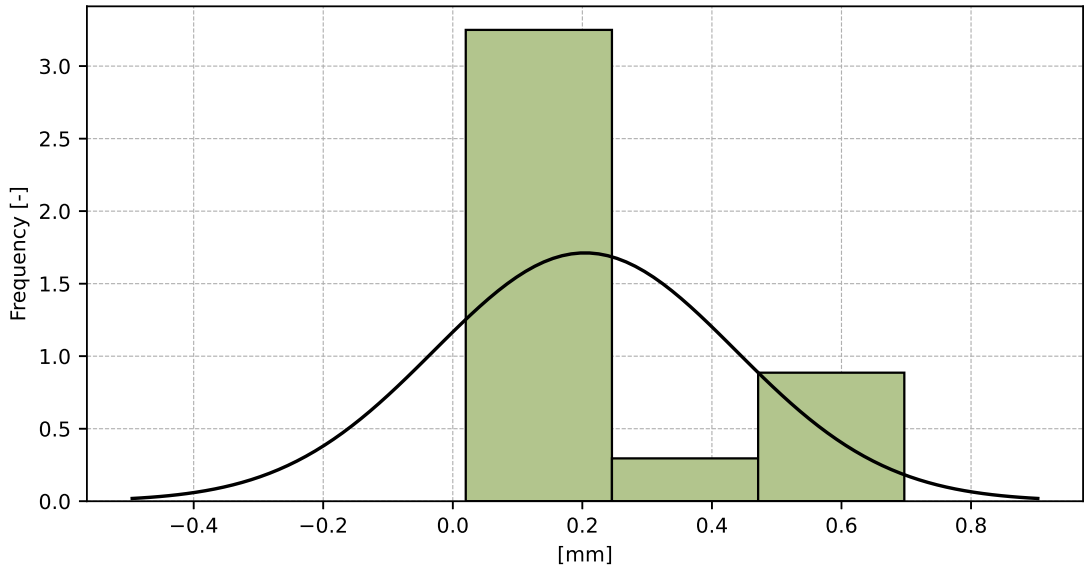

Figure 162: Histogram of all test results

Table 56: Descriptive statistics

Characteristics	[mm]
Average value – $\bar{x}$	0.2
Sample standard deviation – s	0.233
Asigned value – x^*	0.2
Robust standard deviation – s^*	0.236
Measurement uncertainty of asigned value – u_X	0.132
p-value of normality test	0.074 [-]
Interlaboratory standard deviation – s_L	0.23
Repeatability standard deviation – s_r	0.061
Reproducibility standard deviation – s_R	0.238
Repeatability – r	0.17
Reproducibility – R	0.67

20.5 Evaluation of Performance Statistics

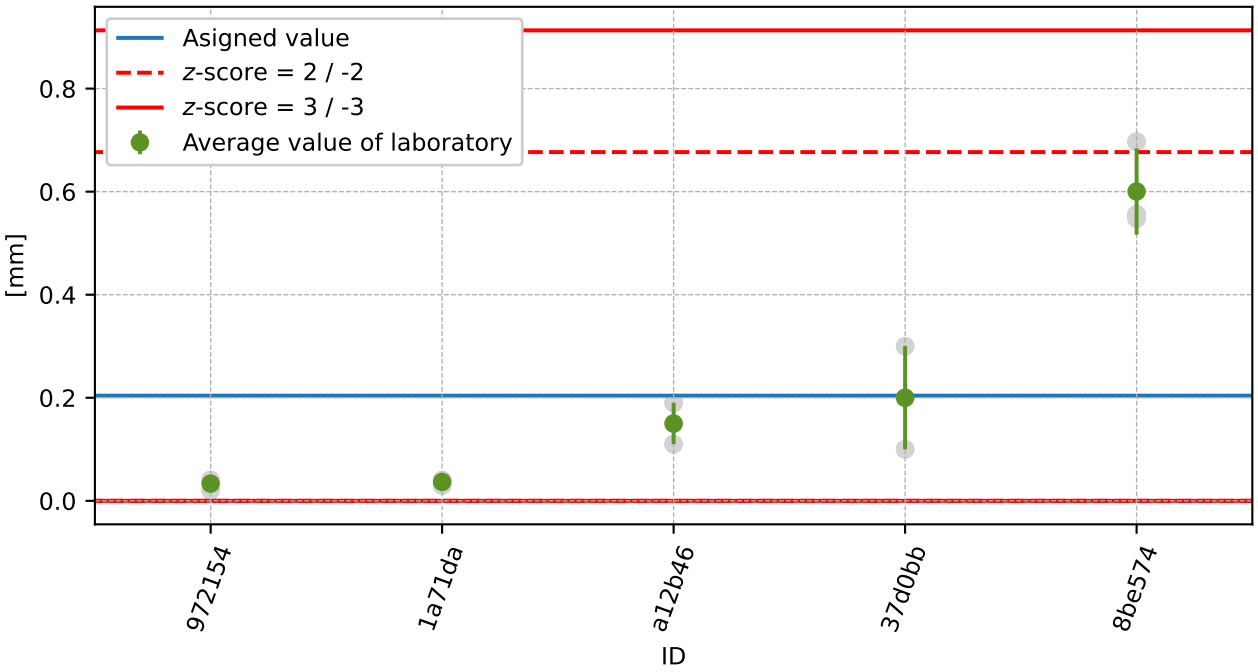

Figure 163: Average values and sample standard deviations

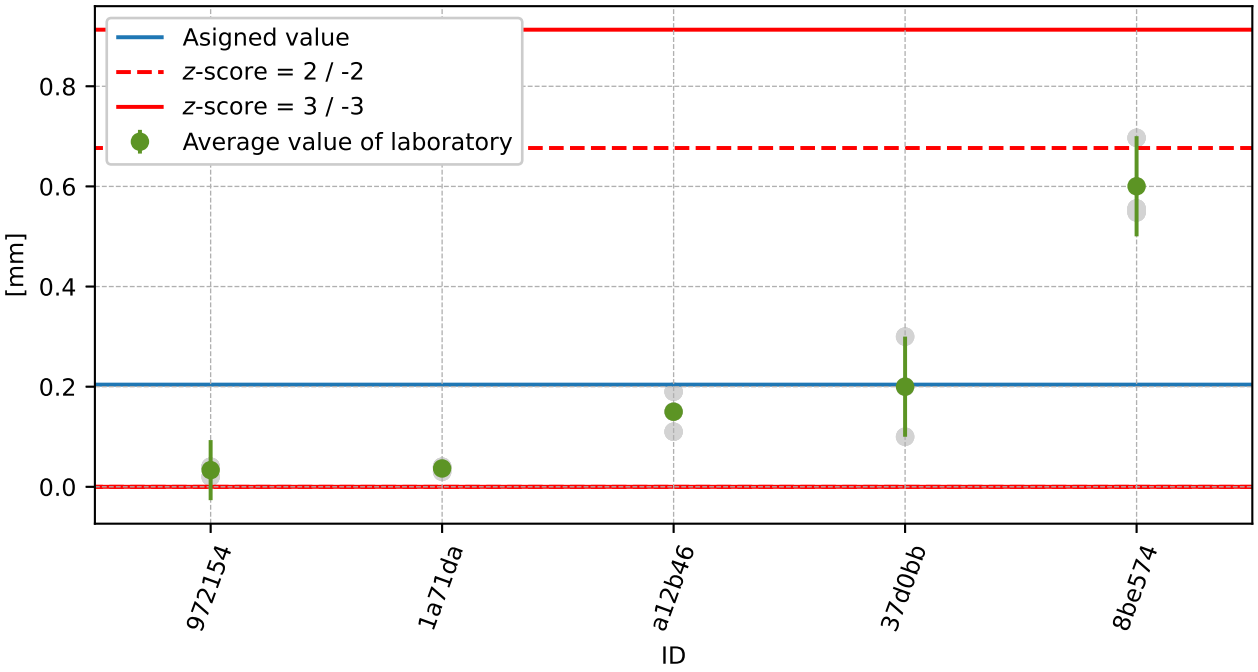

Figure 164: Average values and extended uncertainties of measurement

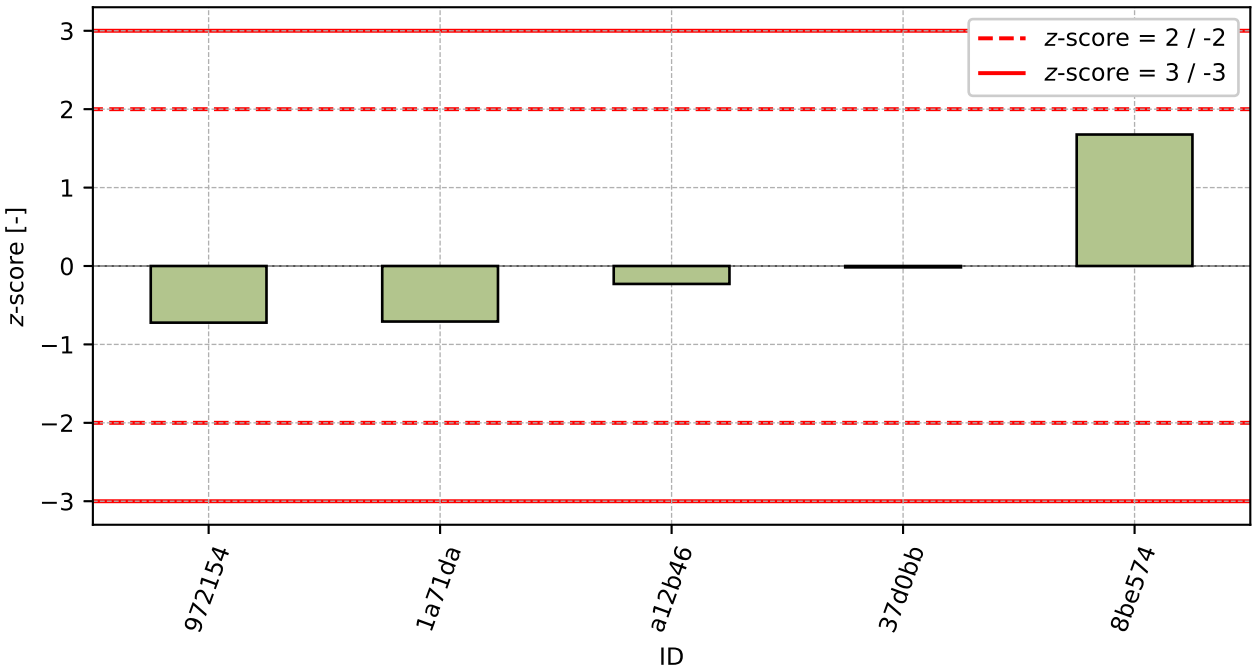

Figure 165: z-score

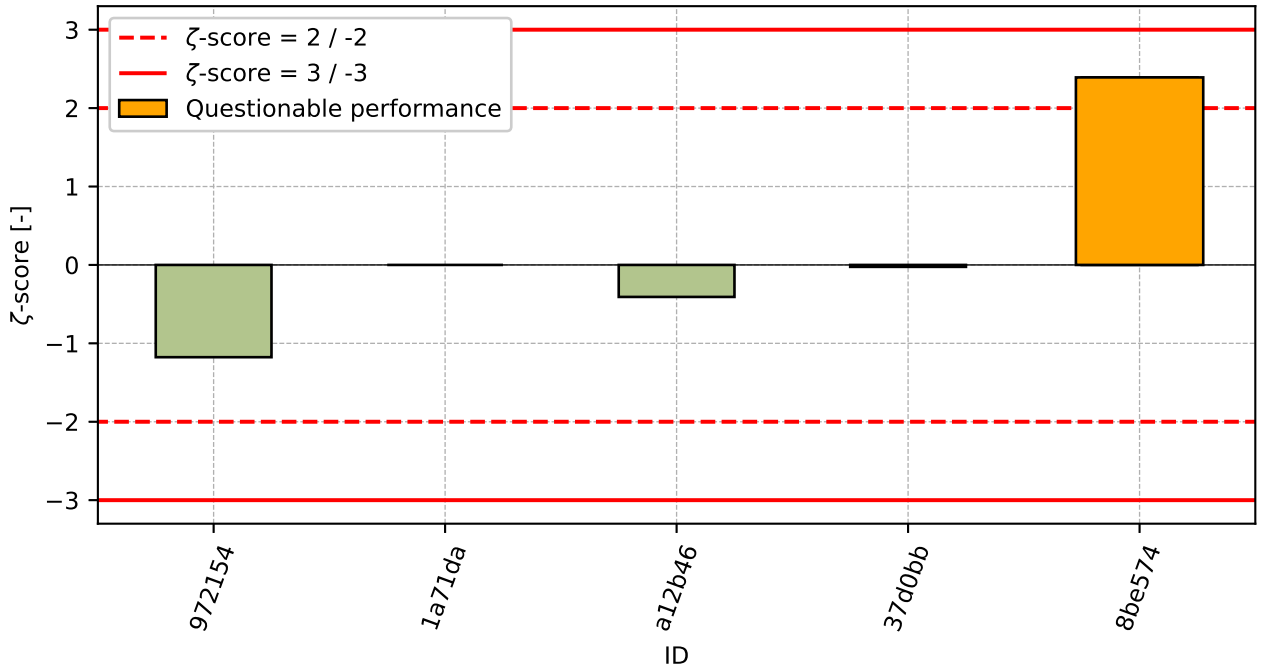

Figure 166: ζ-score

Table 57: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
972154	-0.72	-1.18
1a71da	-0.71	-
a12b46	-0.23	-0.41
37d0bb	-0.02	-0.02
8be574	1.68	2.39

21 Appendix – EN 12004-2 (art. 8.3.3.2) – Adhesion

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

22 Appendix – EN 12004-2 (art. 8.3.3.3) – Adhesion

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