



FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program Strength and Elasticity of Hardened Concrete ZZB 2025/2

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1 Introduction and Important Contacts

In the year 2025, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZZB 2025/2 whose aim was to verify and assess the conformity of test results across laboratories when testing hardened concrete.

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

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The subjects of proficiency testing were the following testing procedures:

1. **EN 12390-3** – Compressive strength of test specimens [1].
2. **EN 12390-5** – Flexural strength of test specimens [2].
3. **EN 12390-6** – Tensile splitting strength of test specimens [3].
4. **EN 12390-7** – Density of hardened concrete [4].
5. **ISO 1920-10** – Determination of static modulus of elasticity in compression [5].
6. **EN 12390-13** – method A – Determination of secant modulus of elasticity in compression [6].
7. **EN 12390-13** – method B – Determination of secant modulus of elasticity in compression [6].
8. **EN 12504-4, ČSN 731371** – Non-destructive testing of concrete [7], [8].
9. **ČSN 731373, EN 12504-2** – Determination of rebound number [9], [10].
10. **EN 1542, ČSN 736242** – Appendix B – Measurement of bond strength by pull-off [11], [12],
11. **EN 1338** – Concrete paving blocks - Requirements and test methods – Appendix E (Total water absorption) [13],
12. **EN 1338** – Concrete paving blocks - Requirements and test methods – Appendix F (Tensile splitting strength) [13],
13. **EN 1338** – Concrete paving blocks - Requirements and test methods – Appendix G (Abrasion resistance) [13],
14. **EN 1339** – Concrete paving flags – Requirements and test methods – Appendix F (Flexural strength and flexural load) [14].

Testing procedures No 6, 7, 8 and 13 were not open due to the low number of participants.

The supplier, BETOTECH s. r. o., was responsible for the preparation of hardened concrete for the PTP. Fresh concrete for the preparation of test samples was taken from one production batch prepared in accordance with methods stipulated in EN 206 [15]. Fresh concrete was poured into test molds, which were always of the same type, and after removal from the molds the test specimens were placed under identical conditions in storage rooms complying with the requirements for individual specifications.

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 [16] and with EN ISO/IEC 17043 [17]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

46 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/Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14
b43ca9	X	X	-	X	X	-	-	-	-	X	-	-	-	-
bd4a89	X	-	-	X	-	-	-	-	X	-	X	-	-	-
3a2fcc	X	-	-	X	-	-	-	-	X	X	-	-	-	-
1ef433	-	-	-	-	-	-	-	-	X	-	-	-	-	-
c3868c	X	-	-	-	-	-	-	-	-	-	-	-	-	-
55eac5	X	-	-	X	-	-	-	-	X	-	-	-	-	-
5a3b2f	X	-	-	-	-	-	-	-	X	-	-	-	-	-
609723	-	-	-	-	X	-	-	-	-	-	-	-	-	-
c8a0bd	X	-	-	-	-	-	-	-	-	-	-	-	-	-
7da7a8	X	X	X	X	-	-	-	-	X	X	-	-	-	-
eb39d7	-	-	-	-	-	-	-	-	-	X	-	-	-	-
92e4d9	-	X	-	-	-	-	-	-	-	-	-	-	-	-
29cd71	-	X	-	-	-	-	-	-	X	-	-	-	-	-
23e169	X	-	-	X	-	-	-	-	-	-	-	-	-	-
5f42be	X	X	-	X	-	-	-	-	-	-	-	-	-	-
e828b4	X	-	-	X	X	-	-	-	-	-	-	-	-	-
2aaaf1	X	-	-	X	-	-	-	-	-	-	-	-	-	-
bfd8b0	X	-	-	X	-	-	-	-	-	-	-	-	-	-
9dd4ce	X	-	-	X	-	-	-	-	-	-	-	-	-	-
f05963	X	-	-	X	-	-	-	-	-	-	-	-	-	-
75dfe7	-	-	-	-	-	-	-	-	-	X	-	-	-	-
05b4e7	X	-	-	X	-	-	-	-	-	X	X	-	-	-
32c0ec	X	-	X	X	X	-	-	-	-	-	-	-	-	-
b86303	-	-	-	-	-	-	-	-	-	X	-	-	-	-
6f139a	X	-	-	X	-	-	-	-	-	-	-	-	-	-
bab4c2	-	-	-	-	X	-	-	-	-	-	-	-	-	-
b29f2f	X	-	-	-	-	-	-	-	-	-	-	-	-	-
5511ca	-	-	-	-	-	-	-	-	-	X	X	-	-	-
82811c	X	X	-	-	-	-	-	-	-	-	-	-	-	-
dcc49a	X	-	-	-	-	-	-	-	-	-	-	-	-	-
c78844	X	-	X	X	-	-	-	-	X	-	-	-	-	-
9cd794	-	X	-	-	-	-	-	-	X	-	-	-	-	-
5b098e	X	-	-	-	-	-	-	-	-	-	-	-	-	-
4f2aef	X	-	-	-	-	-	-	-	-	-	-	-	-	-
2a9d2b	-	-	X	-	-	-	-	-	-	-	-	-	-	-
4cea7c	-	-	-	-	-	-	-	-	-	-	X	-	-	-

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ID/Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14
5e11dd	-	X	-	-	X	-	-	-	-	-	-	-	-	-
13222d	-	-	-	-	-	-	-	-	X	-	-	-	-	-
2f10f3	X	X	-	X	-	-	-	-	-	-	-	-	-	-
130a76	X	-	-	X	-	-	-	-	-	-	-	-	-	-
358a8f	X	-	-	X	-	-	-	-	-	X	-	-	-	-
037dc0	X	X	-	X	-	-	-	-	-	-	X	-	-	-
dffe5d	X	-	-	X	-	-	-	-	-	X	-	-	-	-
15f506	X	X	-	X	-	-	-	-	-	-	-	-	-	-
106898	-	-	X	-	-	-	-	-	X	-	X	-	-	-
9a962b	X	X	-	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
AB „VIAMATIKA“	Granito g. 3-101, Vilnius, LT-02300, Vilnius	LA.01.015
BEST, a.s.	Rybnice 148, Kaznějov, 33151, Česká republika	-
BETOTECH, s.r.o. - Pracoviště Beroun	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - Pracoviště Cheb	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - Pracoviště Jindřichův Hradec	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - Pracoviště Klatovy	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - Pracoviště Most	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - Pracoviště Trutnov	Beroun 660, Beroun, 26601, Česká republika	1195
BETOTECH, s.r.o. - pracoviště Brno	Beroun 660, Beroun, 26601, Česká republika	1195.3
BOKU Wien, Institut fuer Konstruktiven Ingenieurbau	Peter-Jordan-Str. 82, Vienna, 1190, Austria	P0252
Bauchemia T.B., s.r.o., Skúšobné laboratórium Bratislava, Pasienkova 2/D, 821 06 Bratislava	Stanekova 3, Bratislava, 841 03, Slovenská republika	-
Bauchemia T.B., s.r.o., Skúšobné laboratórium Žilina, Pavla Mudroňa 5, 010 01 Žilina	Stanekova 3, Bratislava, 841 03, Slovenská republika	471
Bechtel ENKA UK Limited Ogranak Beograd	Jasički put 52 đ, Kruševac, 37000, Serbia	-
CDDI s.r.o.	Vraclavská 163, Vysoké Mýto, 566 01, Česká republika	-

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Laboratory	Address	Accreditation number
CONTROL-VHS-SK, s.r.o.	Kamenná 14, Žilina, 010 01, Slovenská republika	437/S-317
Cemex Czech Republic s.r.o.	Semtín 102, Pardubice, 53354, Česká republika	1302
Danucem Slovensko a.s., Skúšobné laboratórium Bratislava	Pestovateľská 2, Bratislava, 821 04, Slovenská republika	426/S-313
Elixir Craft doo	Brače Jugovića 2, Prahovo, 19330, Serbia	-
GEOSTAR, spol. s r.o.	Tuřanka 111, Brno - Slatina, 627 00, Česká republika	1373
Institut pro testování a certifikaci, a.s.	třída Tomáše Bati 299, Louky, Zlín, 76302, Česká republika	1007.1
KARYDIS G. & SIA EE	DISTOMOU 97, ATHENS, 10443, ATTICA - GREECE	-
LEPL Levan Samkharauli National Forensics Bureau	84 Chavchavadze Avenue, Tbilisi, 0162, Georgia	GAC-TL-0166
Laborator Central Constructii SRL	CALEA GIULESTI, NR. 242, SECTOR 6, BUCURESTI, 060286, ROMANIA	-
Magnel-Vandepitte Laboratory (University Ghent)	Technologiepark - Zwijnaarde 60, Zwijnaarde (Ghent), 9052, Belgium	220-TEST
Materialversuchsanstalt GmbH	Oberdorf 103, Strass im Zillertal, 6261, Austria	0455
Nucleco S.p.A.	Via Anguillarese 301, Rome, 00123, Italy	01946
Národná diaľničná spoločnosť a.s.	Dúbravská cesta 14, Bratislava, 84104, Slovensko	456/S-328
Panevėžio statybos trestas AB	P. Puzino 1, Panevėžys, 35113, Panevezys	-
QCONTROL s.r.o., odštěpný závod - pracoviště Hradec Králové	Lesní 693, Bílovice nad Svitavou, 66401, Česká republika	1737
QCONTROL s.r.o., odštěpný závod - pracoviště Olomouc	Lesní 693, Bílovice nad Svitavou, 66401, Česká republika	1737
QCONTROL s.r.o., odštěpný závod - pracoviště Rousínov	Lesní 693, Bílovice nad Svitavou, 66401, Česká republika	1737
QUALIFORM SLOVAKIA s.r.o. - pracoviště Bratislava	Pasienková 9 D, Bratislava, 821 06, Česká republika	154/S-301
QUALIFORM SLOVAKIA s.r.o. - pracoviště Svit	Pasienková 9 D, Bratislava, 821 06, Slovenská republika	154/S-301
SQZ, s.r.o. - pracoviště Srch	939/5 U místní dráhy, Olomouc, 779 00, Česká republika	1135.1
Sibotec	Industriepark Oost 6, Beernem, 8730, Belgium	-
Sika Srbija d.o.o.	Patrijarha Pavla 1, Šimanovci, 22310, Republika Srbija	-
Stachema CZ s.r.o. - Zkušební laboratoř - pracoviště 1	Hasičská 1, Zibohlavý, Kolín, 28002, Česká republika	1433
Structural Soils Ltd - Bristol	Structural Soils Ltd, Unit 1A Princess Street, Bedminster, Bristol, BS3 4AG, Bristol	-

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Laboratory	Address	Accreditation number
TESTSTAV group s.r.o.	Orlovská 347/160, Ostrava-Heřmanice, 713 00, Česká republika	1290
TPA ČR, s.r.o. pracoviště č.4 Olomouc	Vrbenská 1821/31, České Budějovice, 370 06, Česká republika	1181
TesTec	Max Hermanlei 35, Brasschaat, 2930, Antwerpen	-
UAB Laboratoriniu bandymu centras	R. Kalantos street 85a, Kaunas, 45293, Lithuania	LA.01.002
University of Technologie	Rechbauerstraße 12, Graz, 8010, Austria	-
University of Zagreb Faculty of Civil Engineering	Fra Andrije Kačića Miošića 26, Zagreb, 10000, Croatia	-
VIALAB CZ s.r.o. - Laboratoř Morava, pracoviště LM4-Ostrava	PO BOX 207, Praha 6, 16041, Česká republika	1170
Ředitelství silnic a dálnic s. p.	Čerčanská 2023/12, Praha 4 - Krč, 140 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 Strength and Elasticity of Hardened Concrete (PT Program) organized by the PT Provider at the SZK FAST. 46 participants (laboratories) took part in the PT Program. The program focused on ordinary standardized testing of hardened concrete with emphasis on its strength and elasticity. 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	2	3	4	5	9	10	11
037dc0	✓	✓	-	✓	-	-	-	✓
05b4e7	✓	-	-	✓	-	-	✓	✓
106898	-	-	✓	-	-	✓	-	✓
130a76	✓	-	-	✓	-	-	-	-
13222d	-	-	-	-	-	✓	-	-
15f506	✓	✓	-	✓	-	-	-	-
1ef433	-	-	-	-	-	?	-	-
23e169	✓	-	-	✓	-	-	-	-
29cd71	-	✓	-	-	-	✓	-	-
2a9d2b	-	-	✓	-	-	-	-	-
2aaaf1	✓	-	-	✓	-	-	-	-
2f10f3	✓	✓	-	✓	-	-	-	-
32c0ec	✓	-	✓	✓	✓	-	-	-
358a8f	✓	-	-	✓	-	-	✓	-
3a2fcc	✓	-	-	✓	-	✓	✓	-
4cea7c	-	-	-	-	-	-	-	✓
4f2aef	✓	-	-	-	-	-	-	-
5511ca	-	-	-	-	-	-	✓	✓
55eac5	✓	-	-	✓	-	✓	-	-
5a3b2f	?	-	-	-	-	X	-	-
5b098e	✓	-	-	-	-	-	-	-
5e11dd	-	✓	-	-	✓	-	-	-
5f42be	✓	✓	-	✓	-	-	-	-
609723	-	-	-	-	✓	-	-	-
6f139a	✓	-	-	✓	-	-	-	-
75dfe7	-	-	-	-	-	-	✓	-
7da7a8	✓	✓	✓	✓	-	✓	✓	-
82811c	✓	✓	-	-	-	-	-	-

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ID / Method	1	2	3	4	5	9	10	11
92e4d9	-	✓	-	-	-	-	-	-
9a962b	✓	✓	-	✓	-	-	-	-
9cd794	-	✓	-	-	-	✓	-	-
9dd4ce	✓	-	-	✓	-	-	-	-
b29f2f	✓	-	-	-	-	-	-	-
b43ca9	✓	?	-	✓	✓	-	✓	-
b86303	-	-	-	-	-	-	?	-
bab4c2	-	-	-	-	✓	-	-	-
bd4a89	✓	-	-	✓	-	✓	-	✓
bfd8b0	✓	-	-	✓	-	-	-	-
c3868c	?	-	-	-	-	-	-	-
c78844	✓	-	✓	✓	-	-	-	-
c8a0bd	✓	-	-	-	-	-	-	-
dcc49a	✓	-	-	-	-	-	-	-
dffe5d	✓	-	-	?	-	-	✓	-
e828b4	✓	-	-	✓	✓	-	-	-
eb39d7	-	-	-	-	-	-	✓	-
f05963	✓	-	-	✓	-	-	-	-

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

1 Appendix – EN 12390-3 – Compressive strength of test specimens

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 [%]
c3868c	50.4	56.7	56.4	2.00	54.5	3.55	6.52
5a3b2f	55.0	55.0	55.0	-	55.0	0.00	0.00
130a76	57.8	56.0	58.6	1.29	57.5	1.33	2.32
c8a0bd	59.0	57.6	57.3	1.00	58.0	0.91	1.57
3a2fcc	57.8	56.5	60.2	1.07	58.2	1.88	3.23
05b4e7	58.1	57.6	59.2	2.90	58.3	0.82	1.40
2f10f3	60.0	57.6	57.5	1.41	58.4	1.42	2.42
23e169	58.4	59.7	57.4	0.50	58.5	1.15	1.97
dffe5d	60.1	57.9	58.4	-	58.8	1.15	1.96
c78844	57.7	60.0	59.1	-	58.9	1.16	1.97
5b098e	58.6	59.3	60.6	0.17	59.5	1.01	1.71
82811c	58.3	60.2	60.3	0.37	59.6	1.13	1.89
9a962b	60.9	60.2	57.8	2.00	59.6	1.63	2.73
2aaaf1	58.7	57.6	62.6	1.70	59.6	2.63	4.41
bd4a89	58.8	60.3	60.2	2.20	59.8	0.84	1.40
e828b4	59.5	59.9	61.9	1.70	60.4	1.29	2.13
6f139a	59.0	60.8	62.1	-	60.6	1.56	2.57
358a8f	61.1	61.9	59.8	1.00	60.9	1.06	1.74
9dd4ce	61.0	62.0	60.4	2.60	61.1	0.81	1.32
037dc0	60.7	61.4	61.5	4.20	61.2	0.44	0.71
55eac5	61.4	62.0	60.5	1.50	61.3	0.75	1.23
f05963	61.7	63.2	59.5	2.20	61.5	1.86	3.03
7da7a8	61.3	61.6	62.2	3.40	61.7	0.46	0.74
32c0ec	62.7	60.6	62.1	2.90	61.8	1.08	1.75
b43ca9	61.0	60.8	63.8	1.60	61.9	1.68	2.71
15f506	63.8	62.6	59.8	1.09	62.1	2.05	3.31
4f2aef	63.0	60.8	62.6	4.05	62.1	1.17	1.89
5f42be	61.7	64.1	61.6	2.80	62.5	1.42	2.27
b29f2f	63.0	61.3	63.2	8.00	62.5	1.04	1.67
bfd8b0	63.2	63.3	61.5	3.00	62.7	1.01	1.61
dcc49a	65.5	60.6	62.2	6.80	62.8	2.50	3.98

1.2 The Numerical Procedure for Determining Outliers

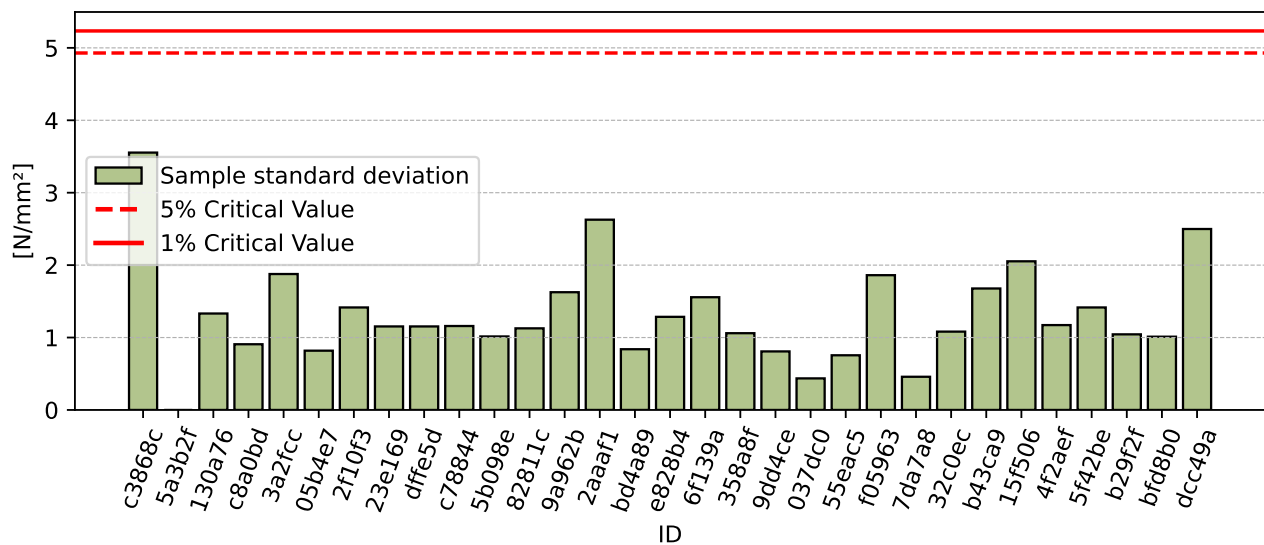


Figure 1: **Cochran's test** - sample standard deviations

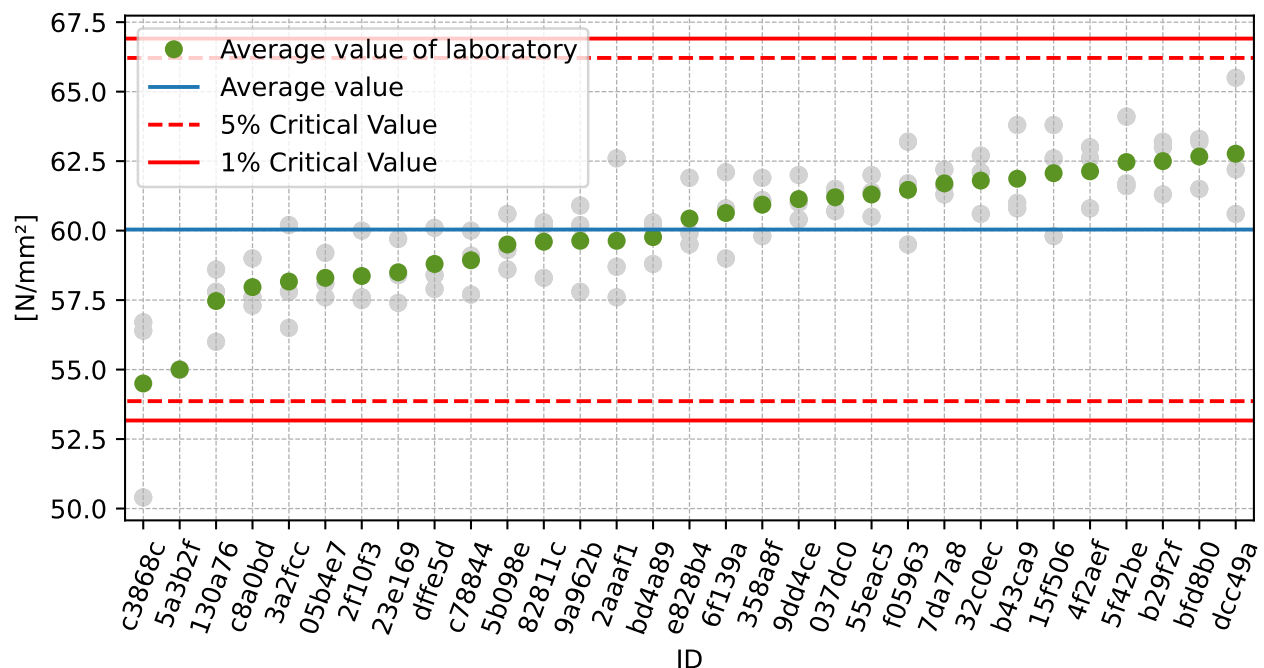


Figure 2: **Grubbs' test** - average values

1.3 Mandel's Statistics

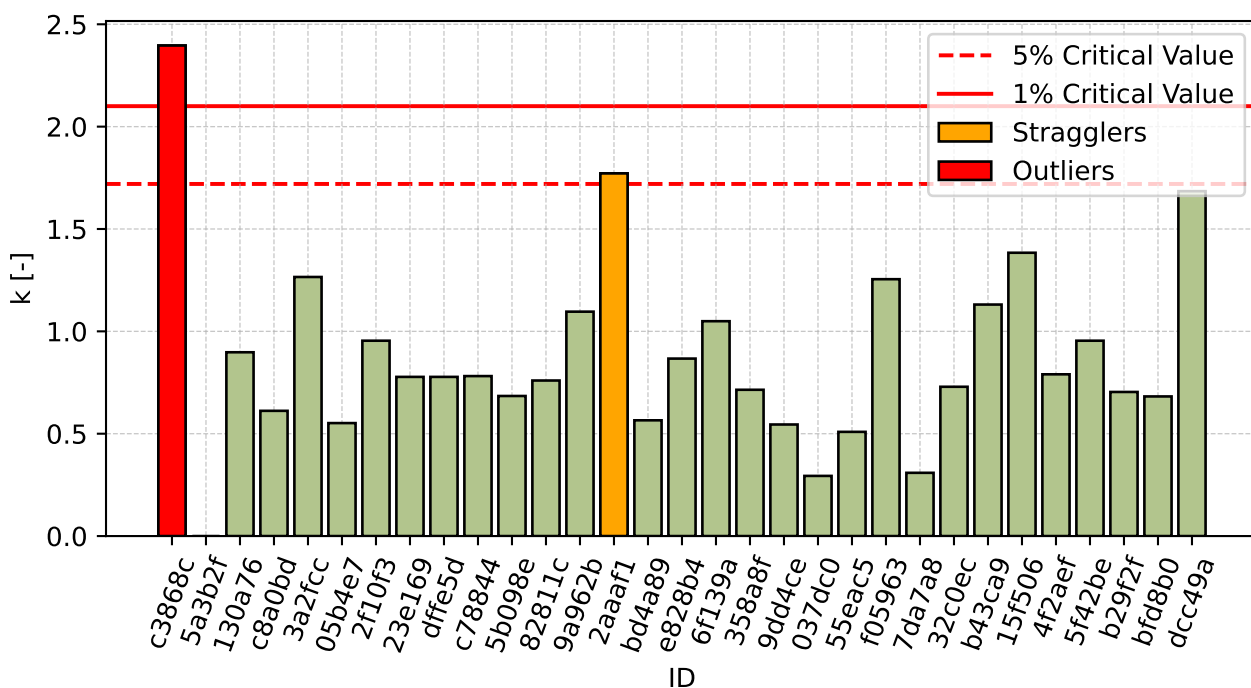


Figure 3: Intralaboratory Consistency Statistic

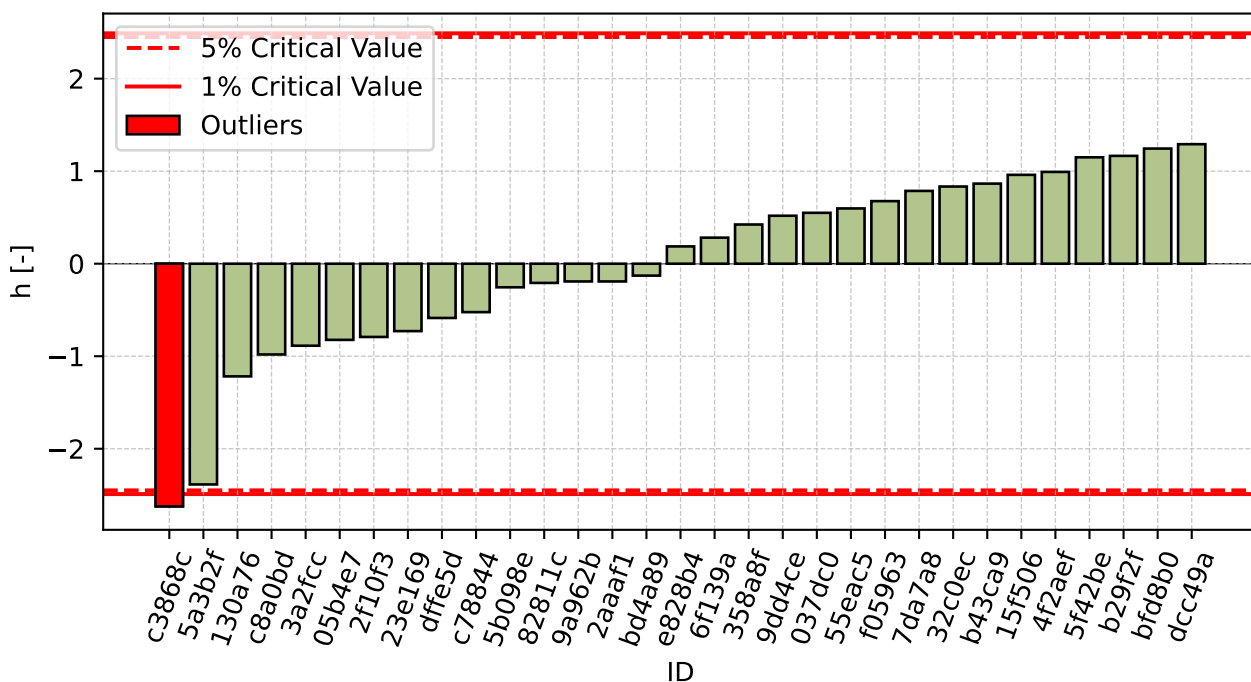


Figure 4: Interlaboratory Consistency Statistic

1.4 Descriptive statistics

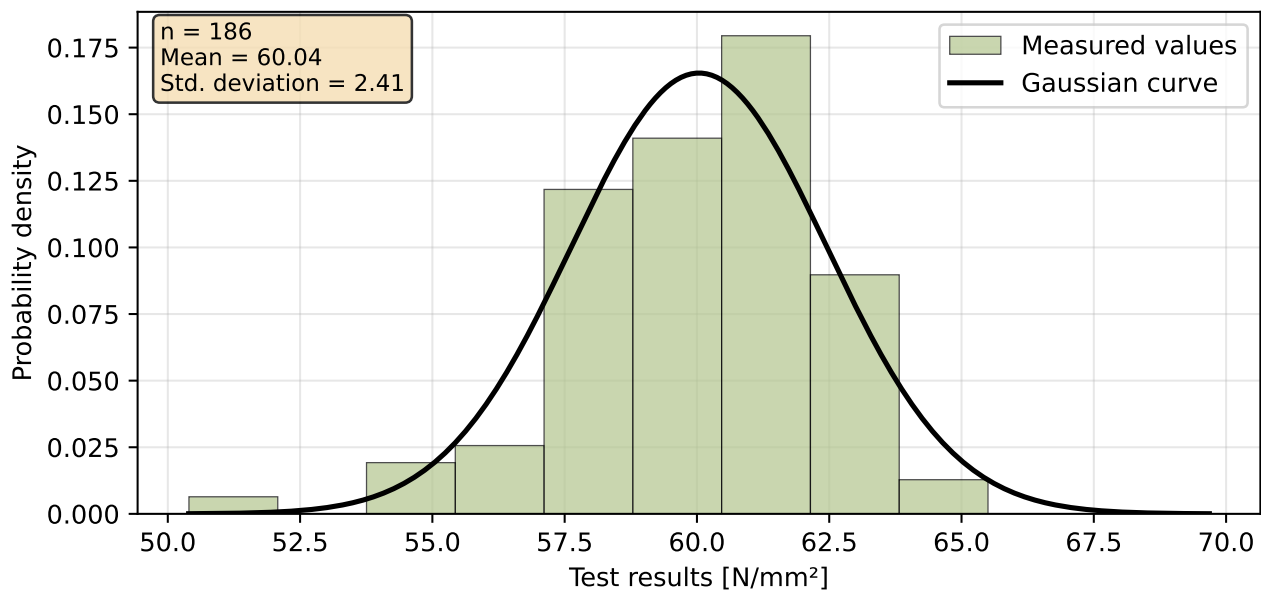


Figure 5: Histogram of all test results

Table 5: Descriptive statistics

Characteristics	[N/mm ²]
Average value – $\bar{x}$	60.0
Sample standard deviation – s	2.11
Assigned value – x^*	60.0
Robust standard deviation – s^*	2.11
Measurement uncertainty of assigned value – u_X	0.38
p -value of normality test	0.015 [-]
Interlaboratory standard deviation – s_L	1.93
Repeatability standard deviation – s_r	1.48
Reproducibility standard deviation – s_R	2.43
Repeatability – r	4.2
Reproducibility – R	6.8

1.5 Evaluation of Performance Statistics

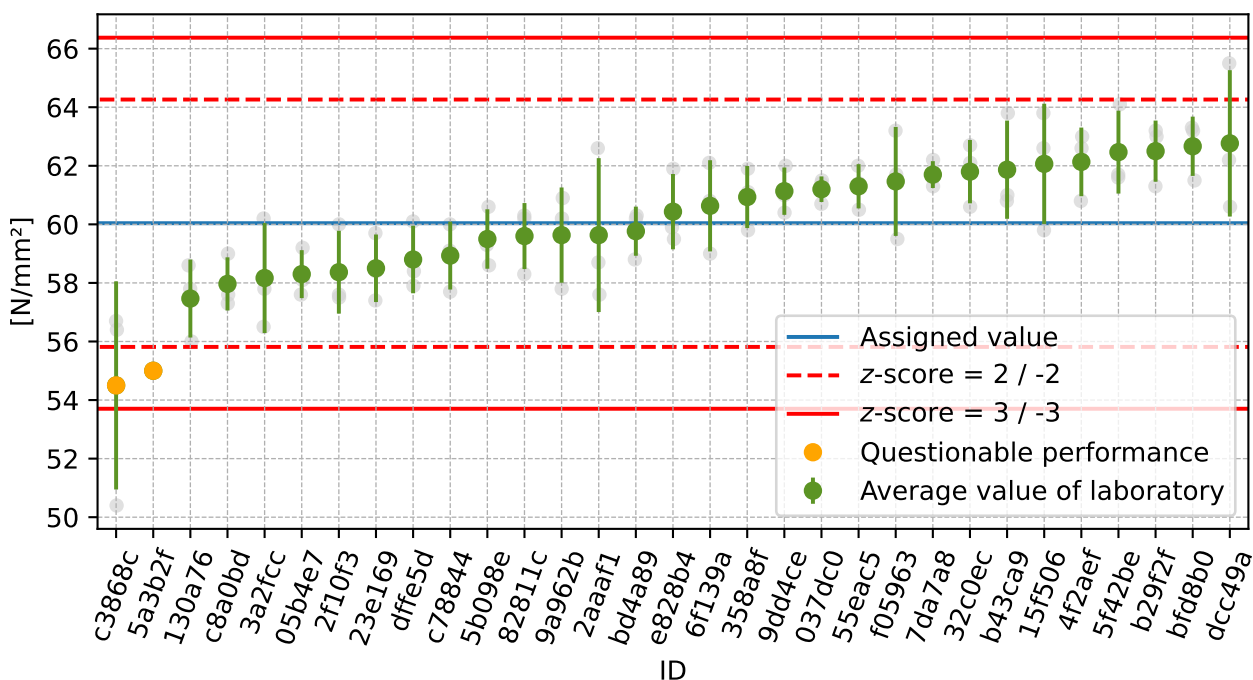


Figure 6: Average values and sample standard deviations

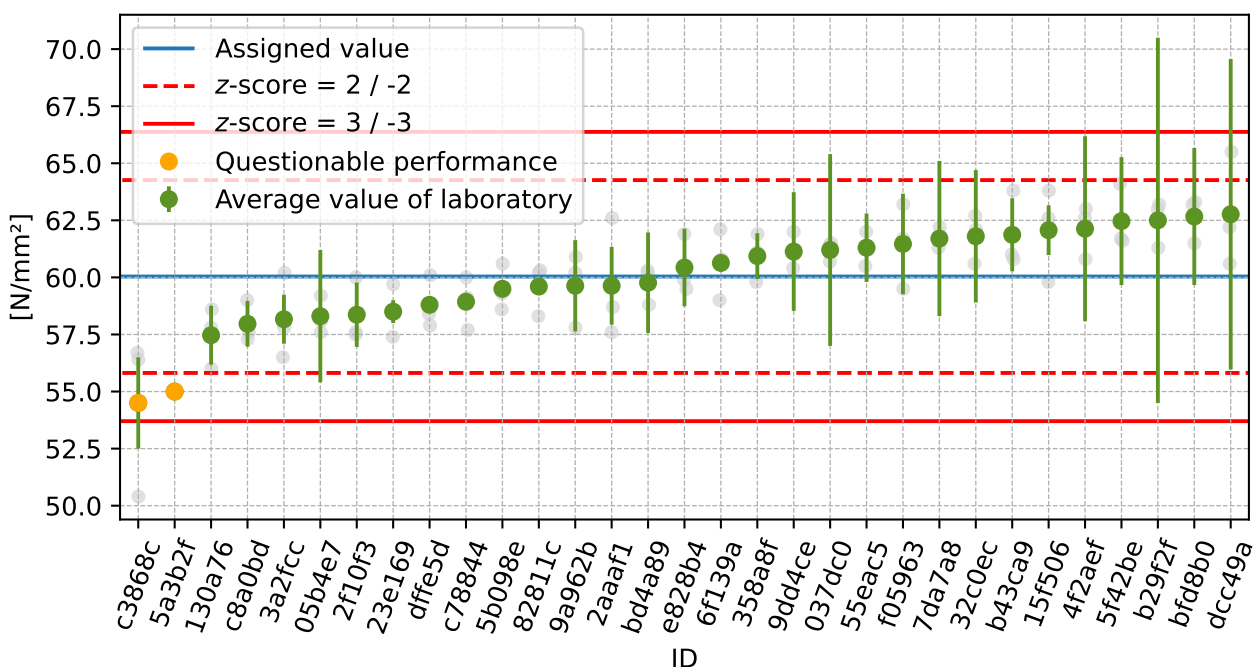


Figure 7: Average values and extended uncertainties of measurement

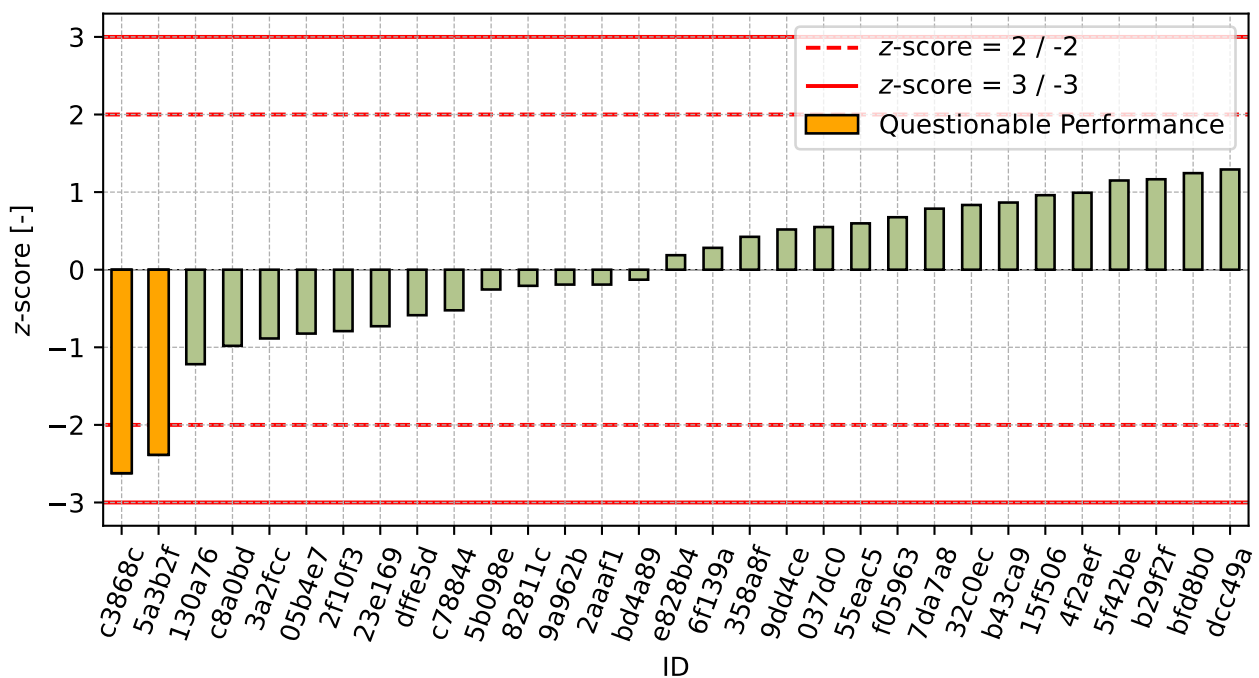


Figure 8: z-score

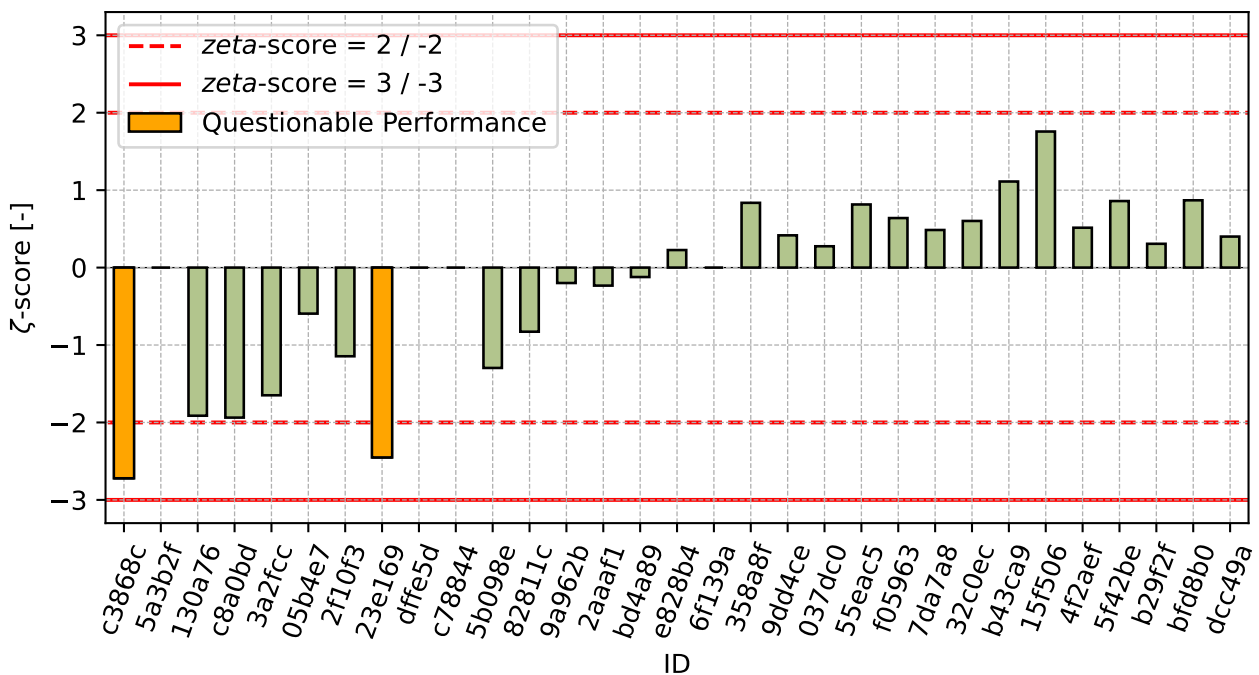
Figure 9: ζ -score

Table 6: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
c3868c	-2.62	-2.72
5a3b2f	-2.39	-
130a76	-1.22	-1.91
c8a0bd	-0.98	-1.94
3a2fcc	-0.89	-1.65
05b4e7	-0.82	-0.59
2f10f3	-0.79	-1.15
23e169	-0.73	-2.45
dffe5d	-0.59	-
c78844	-0.52	-
5b098e	-0.26	-1.3
82811c	-0.21	-0.83
9a962b	-0.19	-0.2
2aaaf1	-0.19	-0.23
bd4a89	-0.13	-0.12
e828b4	0.19	0.23
6f139a	0.28	-
358a8f	0.42	0.84
9dd4ce	0.52	0.42
037dc0	0.55	0.28
55eac5	0.6	0.82
f05963	0.68	0.64
7da7a8	0.79	0.49
32c0ec	0.83	0.6
b43ca9	0.87	1.11
15f506	0.96	1.76
4f2aef	0.99	0.51
5f42be	1.15	0.86
b29f2f	1.17	0.31
bfd8b0	1.24	0.87
dcc49a	1.29	0.4

2 Appendix – EN 12390-5 – Flexural strength of test specimens

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/mm ²]			u_X [N/mm ²]	$\bar{x}$ [N/mm ²]	s_0 [N/mm ²]	V_X [%]
b43ca9	4.1	4.2	4.1	0.12	4.1	0.06	1.40
2f10f3	5.4	5.5	5.2	0.08	5.4	0.15	2.85
82811c	6.4	5.9	4.4	0.10	5.6	1.04	18.70
9a962b	6.1	6.1	6.7	1.00	6.3	0.35	5.50
5e11dd	6.6	6.1	6.7	0.90	6.5	0.32	4.97
29cd71	6.8	6.2	6.5	-	6.5	0.30	4.62
7da7a8	7.0	6.6	6.9	0.50	6.8	0.21	3.05
92e4d9	6.9	7.0	7.2	-	7.0	0.15	2.17
9cd794	7.4	7.1	6.7	-	7.1	0.35	4.97
037dc0	7.7	7.2	6.9	0.49	7.3	0.40	5.56
15f506	8.2	7.9	7.6	0.19	7.9	0.30	3.80
5f42be	8.3	8.5	8.4	0.70	8.4	0.10	1.19

2.2 The Numerical Procedure for Determining Outliers

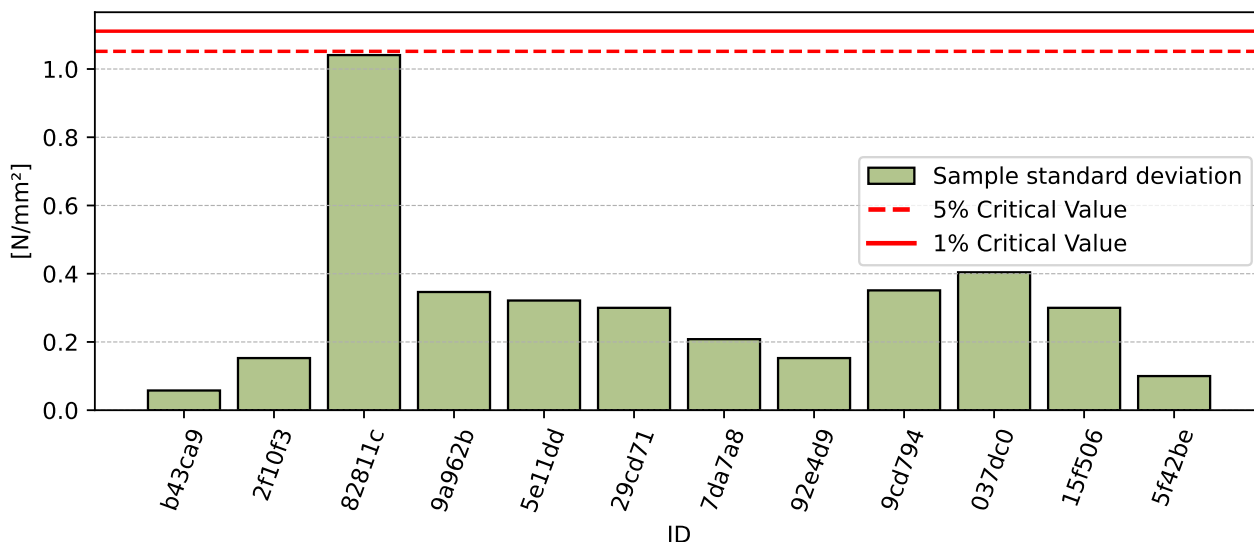
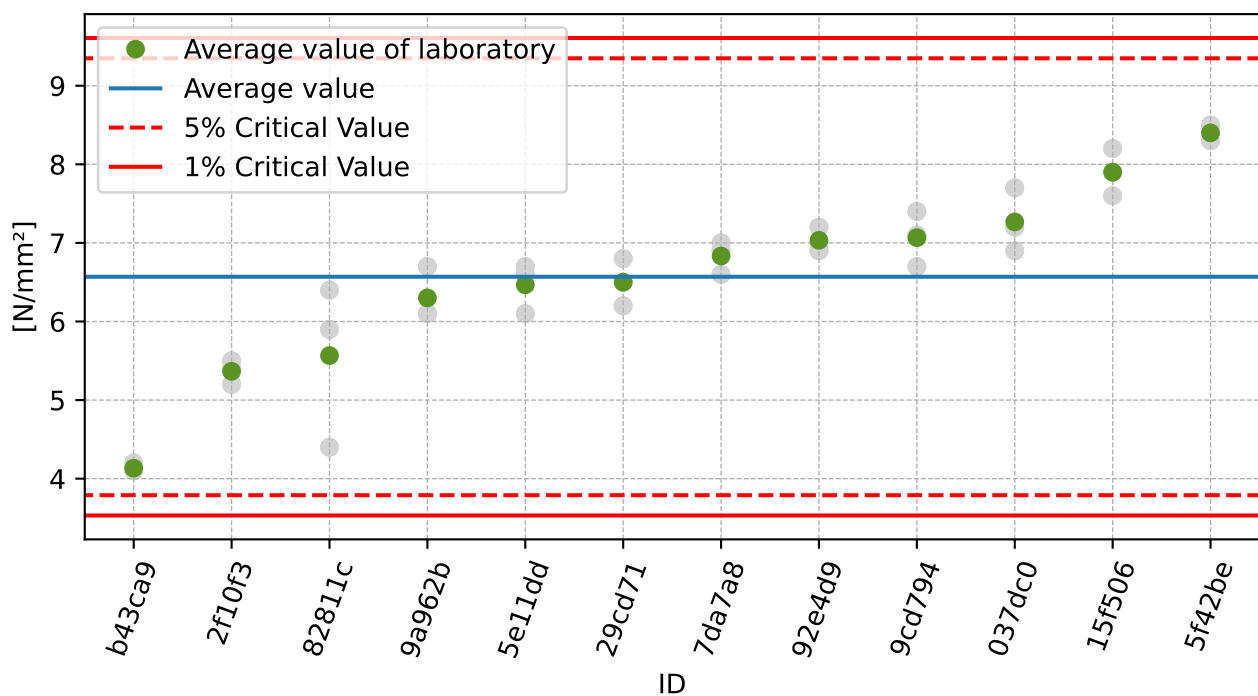


Figure 10: **Cochran's test** - sample standard deviations

Figure 11: **Grubbs' test** - average values

2.3 Mandel's Statistics

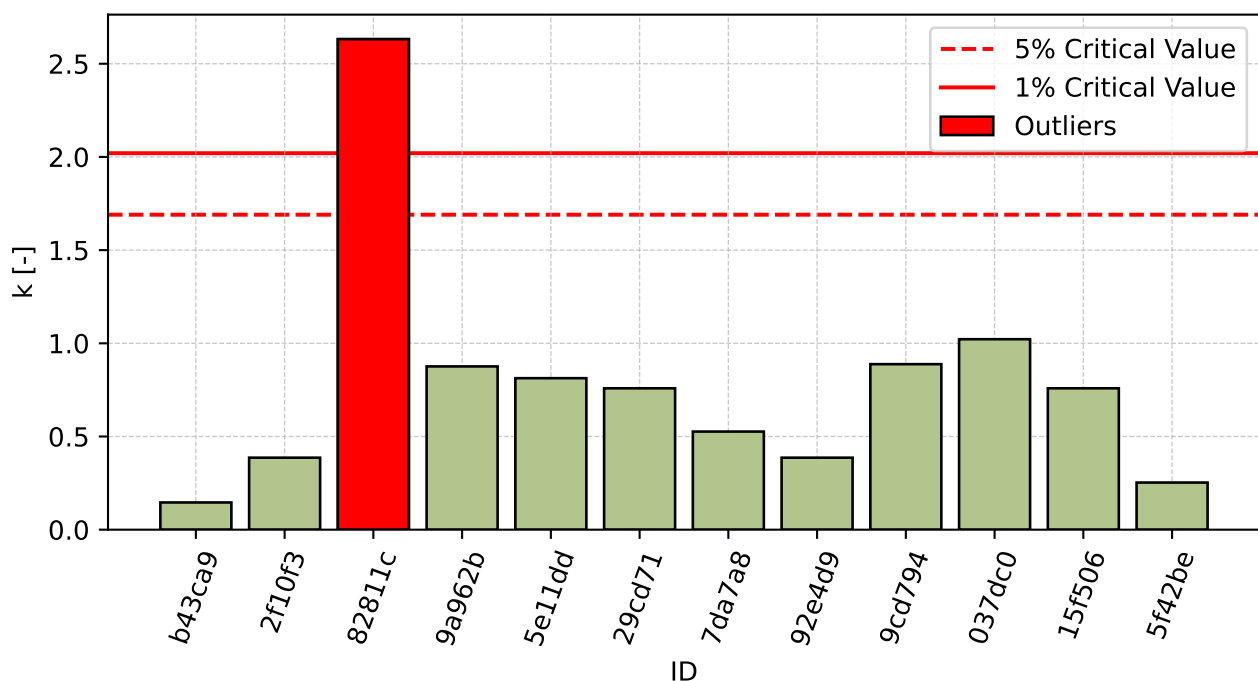


Figure 12: Intralaboratory Consistency Statistic

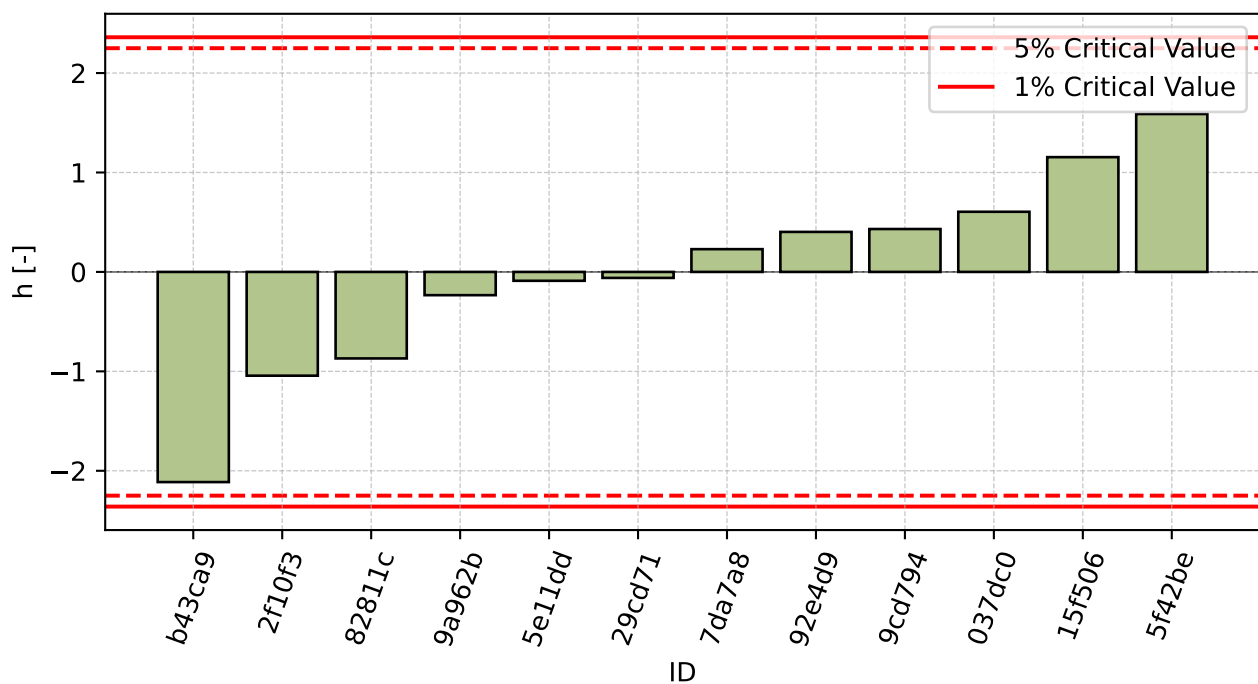


Figure 13: Interlaboratory Consistency Statistic

2.4 Descriptive statistics

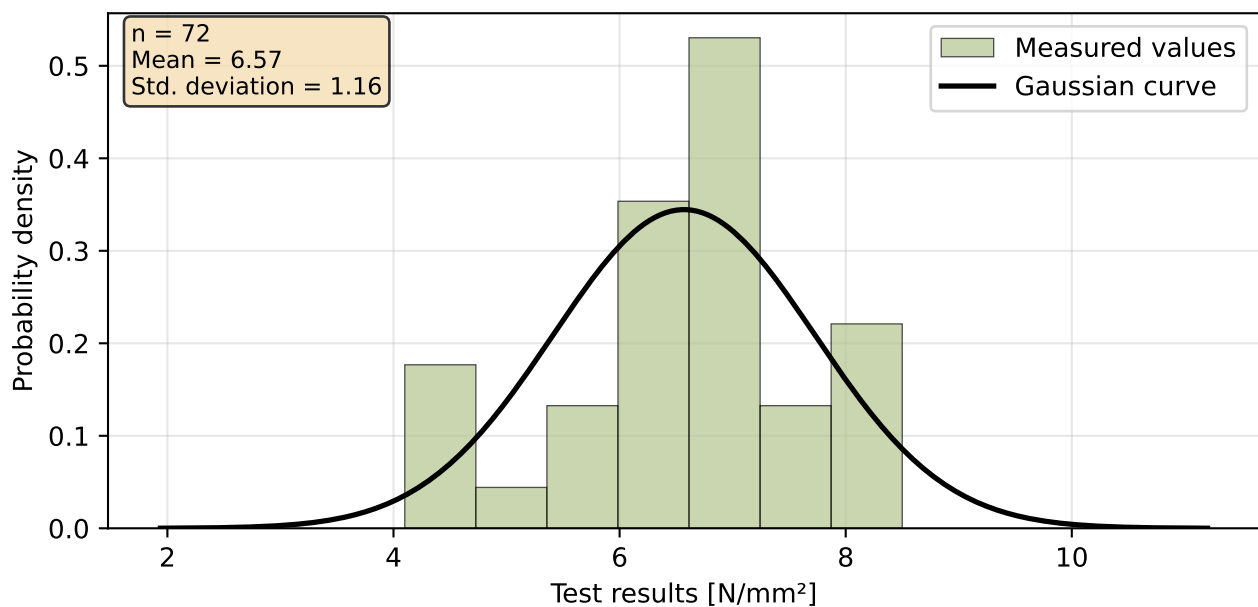


Figure 14: Histogram of all test results

Table 8: Descriptive statistics

Characteristics	[N/mm ²]
Average value – $\bar{x}$	6.6
Sample standard deviation – s	1.15
Assigned value – x^*	6.6
Robust standard deviation – s^*	1.15
Measurement uncertainty of assigned value – u_X	0.33
p -value of normality test	0.066 [-]
Interlaboratory standard deviation – s_L	1.13
Repeatability standard deviation – s_r	0.4
Reproducibility standard deviation – s_R	1.2
Repeatability – r	1.1
Reproducibility – R	3.4

2.5 Evaluation of Performance Statistics

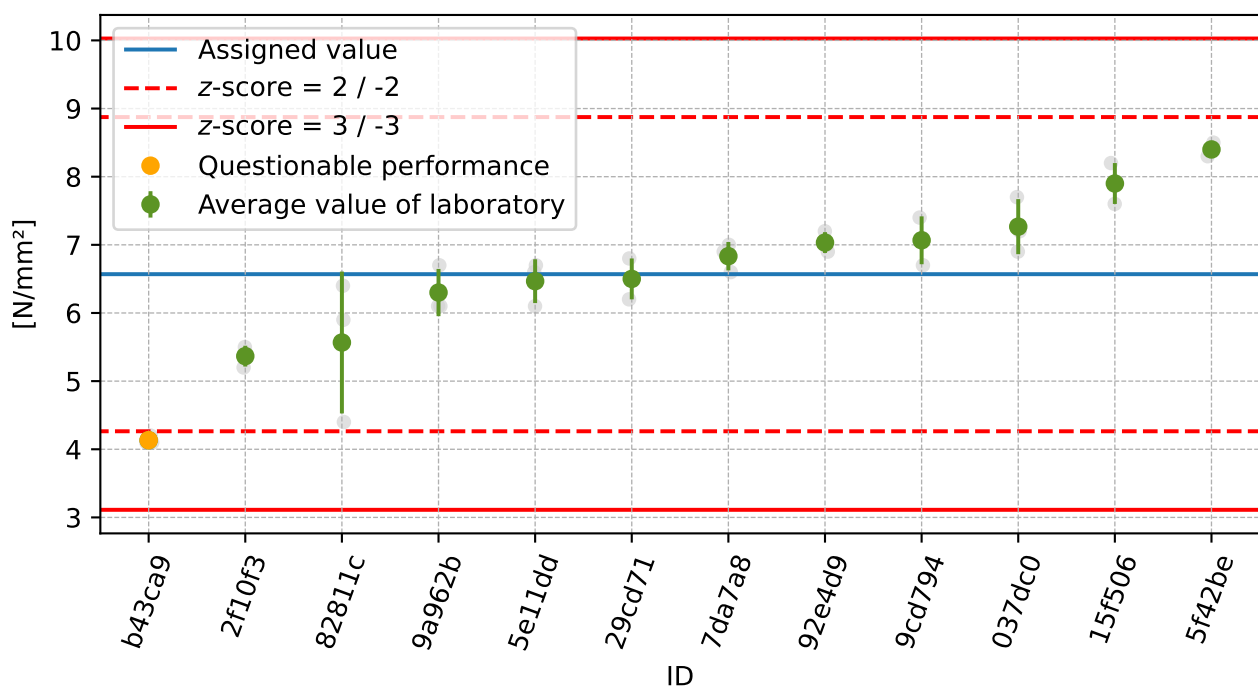


Figure 15: Average values and sample standard deviations

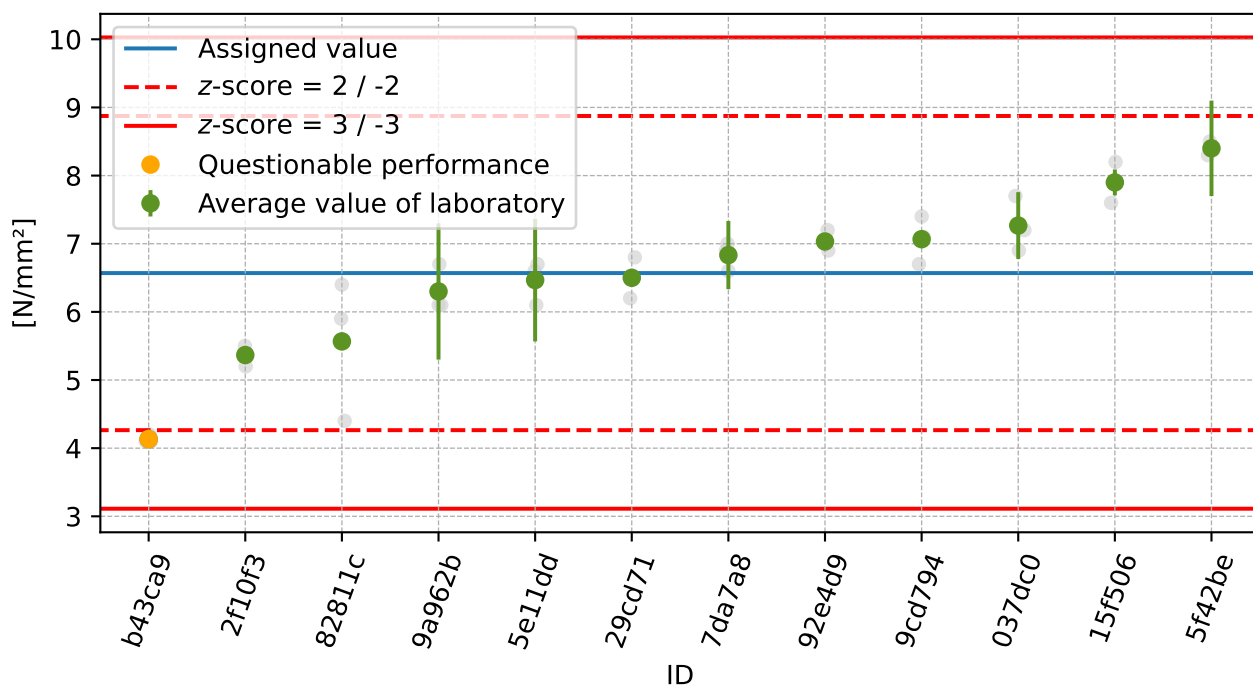


Figure 16: Average values and extended uncertainties of measurement

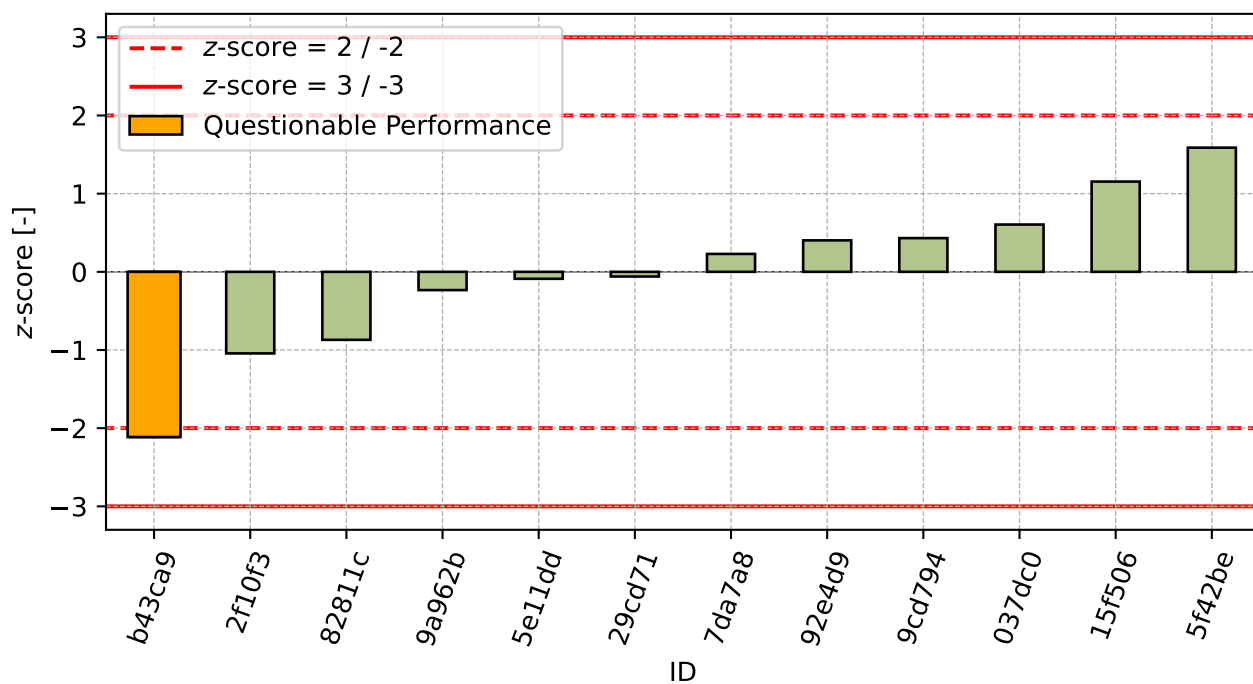
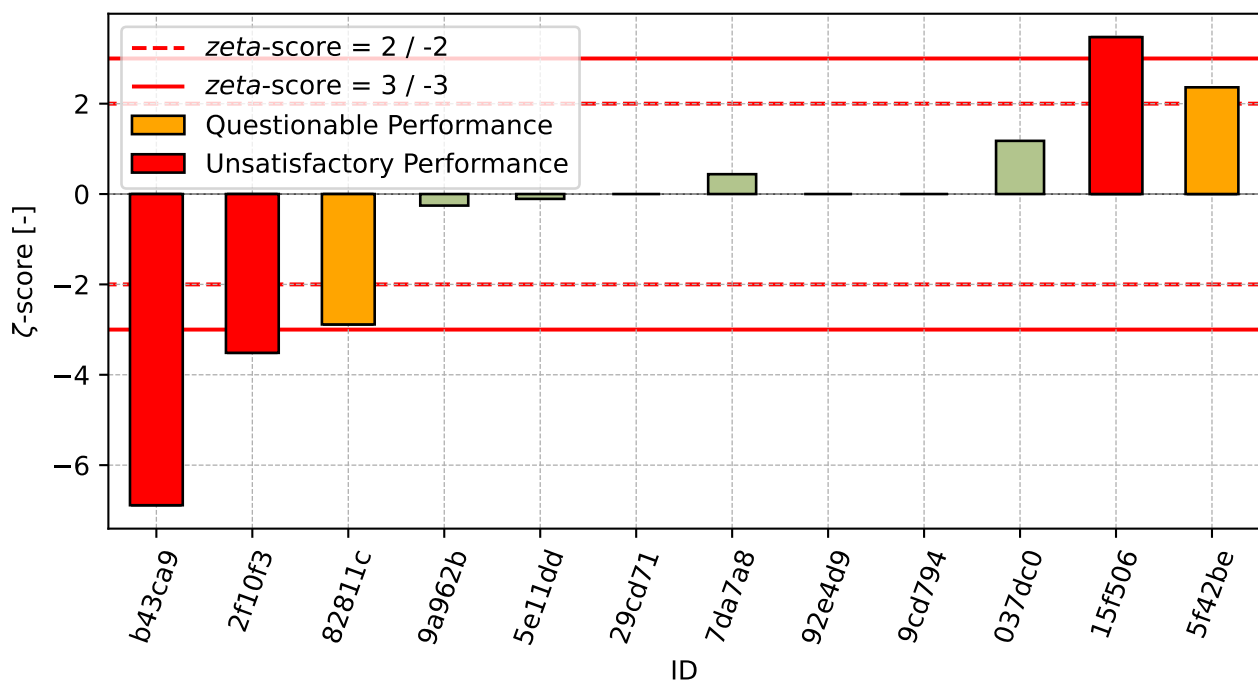


Figure 17: z-score

Figure 18: ζ -scoreTable 9: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
b43ca9	-2.11	-6.89
2f10f3	-1.04	-3.51
82811c	-0.87	-2.89
9a962b	-0.23	-0.26
5e11dd	-0.09	-0.11
29cd71	-0.06	-
7da7a8	0.23	0.44
92e4d9	0.4	-
9cd794	0.43	-
037dc0	0.6	1.18
15f506	1.15	3.47
5f42be	1.59	2.36

3 Appendix – EN 12390-6 – Tensile splitting strength of test specimens

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/mm ²]			u_X [N/mm ²]	$\bar{x}$ [N/mm ²]	s_0 [N/mm ²]	V_X [%]
c78844	3.9	4.1	-	-	4.0	0.14	3.54
2a9d2b	4.5	4.6	4.1	-	4.4	0.26	6.01
7da7a8	4.3	4.8	4.5	0.30	4.5	0.25	5.55
32c0ec	4.5	5.0	4.7	0.06	4.7	0.25	5.32
106898	5.2	5.1	5.3	0.30	5.2	0.10	1.92

3.2 The Numerical Procedure for Determining Outliers

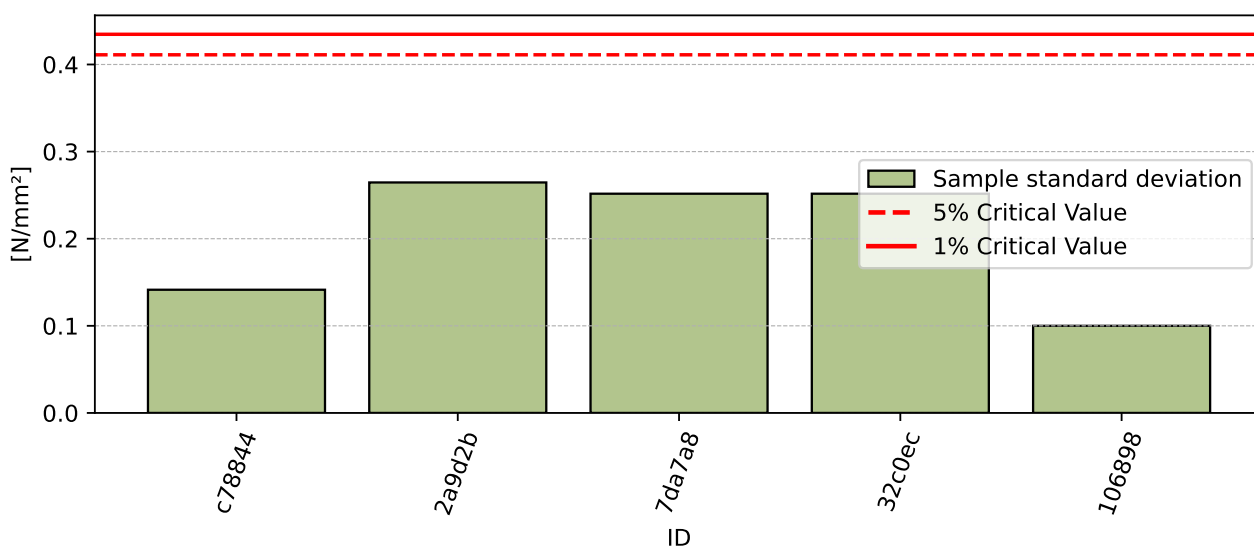
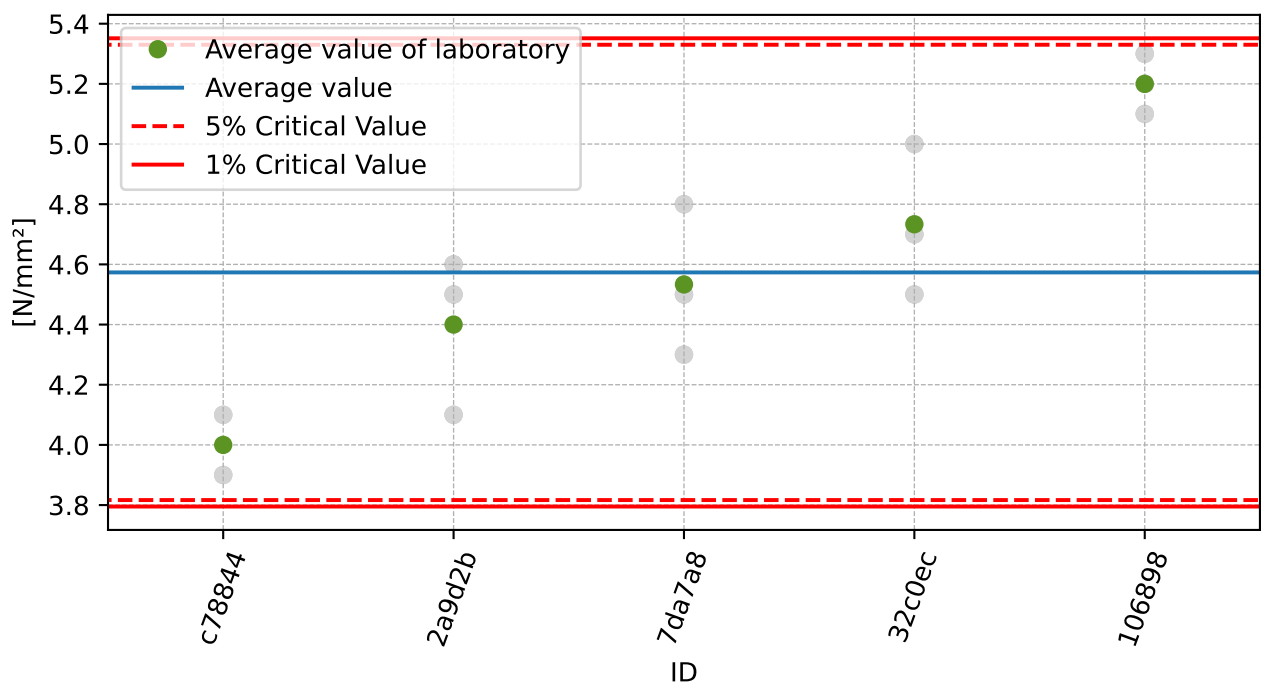


Figure 19: **Cochran's test** - sample standard deviations

Figure 20: **Grubbs' test** - average values

3.3 Mandel's Statistics

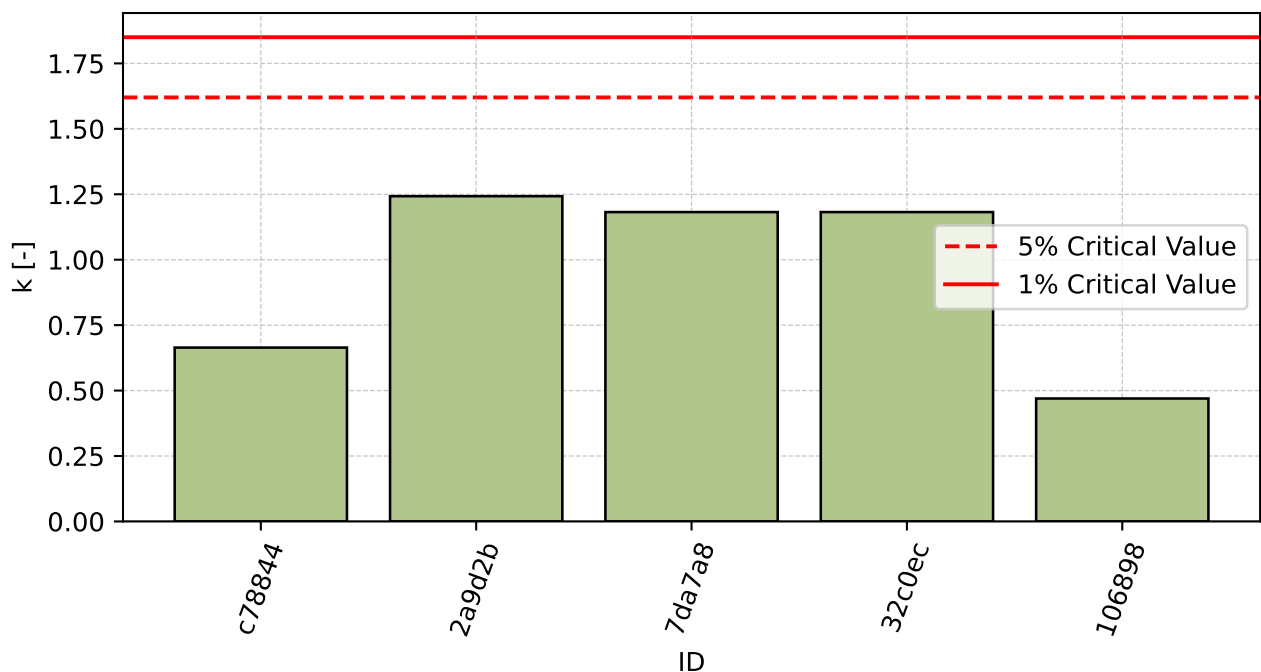


Figure 21: Intralaboratory Consistency Statistic

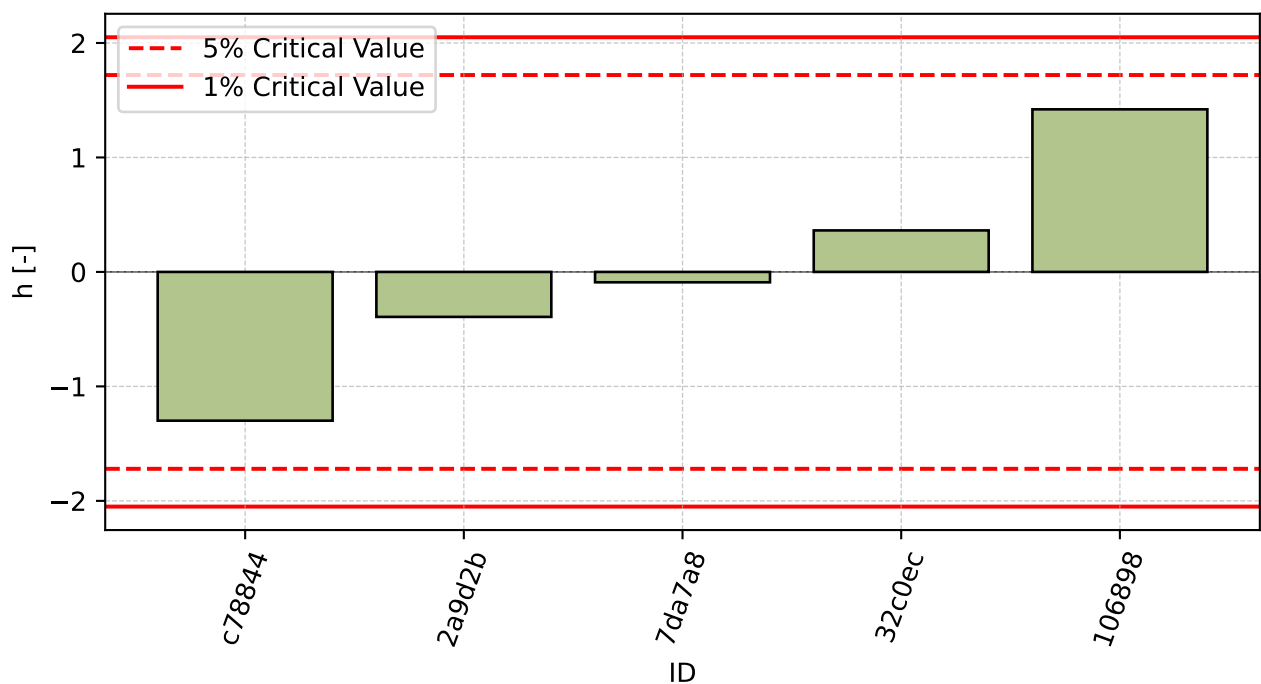


Figure 22: Interlaboratory Consistency Statistic

3.4 Descriptive statistics

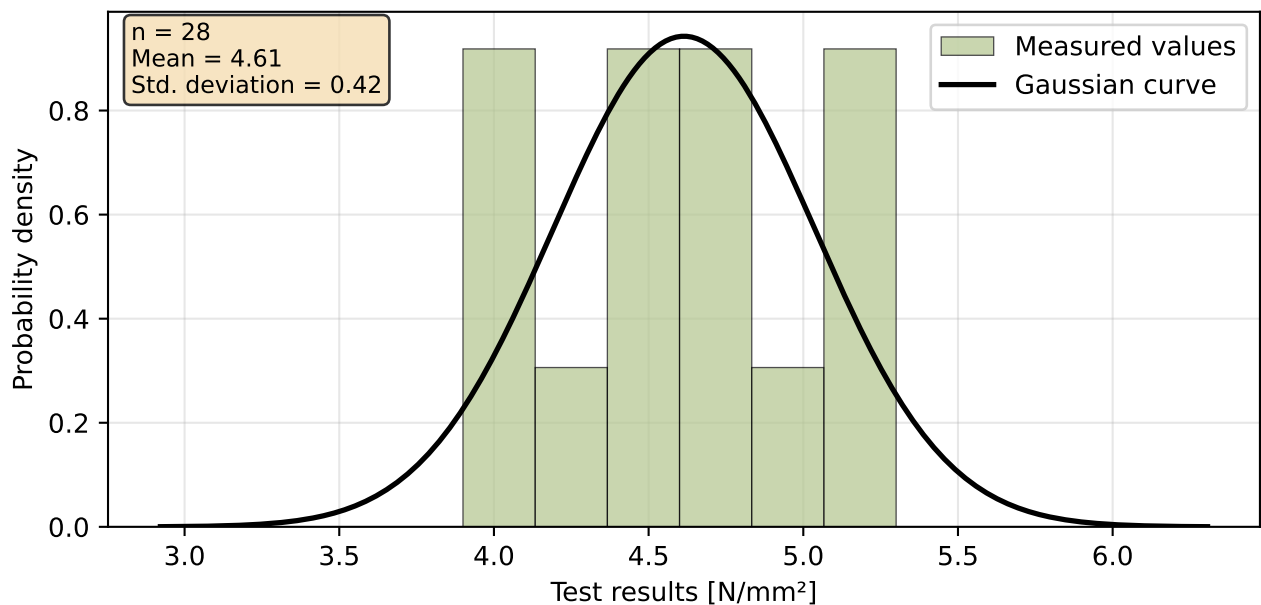


Figure 23: Histogram of all test results

Table 11: Descriptive statistics

Characteristics	[N/mm ²]
Average value – $\bar{x}$	4.6
Sample standard deviation – s	0.44
Assigned value – x^*	4.6
Robust standard deviation – s^*	0.44
Measurement uncertainty of assigned value – u_X	0.2
p -value of normality test	0.783 [-]
Interlaboratory standard deviation – s_L	0.42
Repeatability standard deviation – s_r	0.21
Reproducibility standard deviation – s_R	0.47
Repeatability – r	0.6
Reproducibility – R	1.3

3.5 Evaluation of Performance Statistics

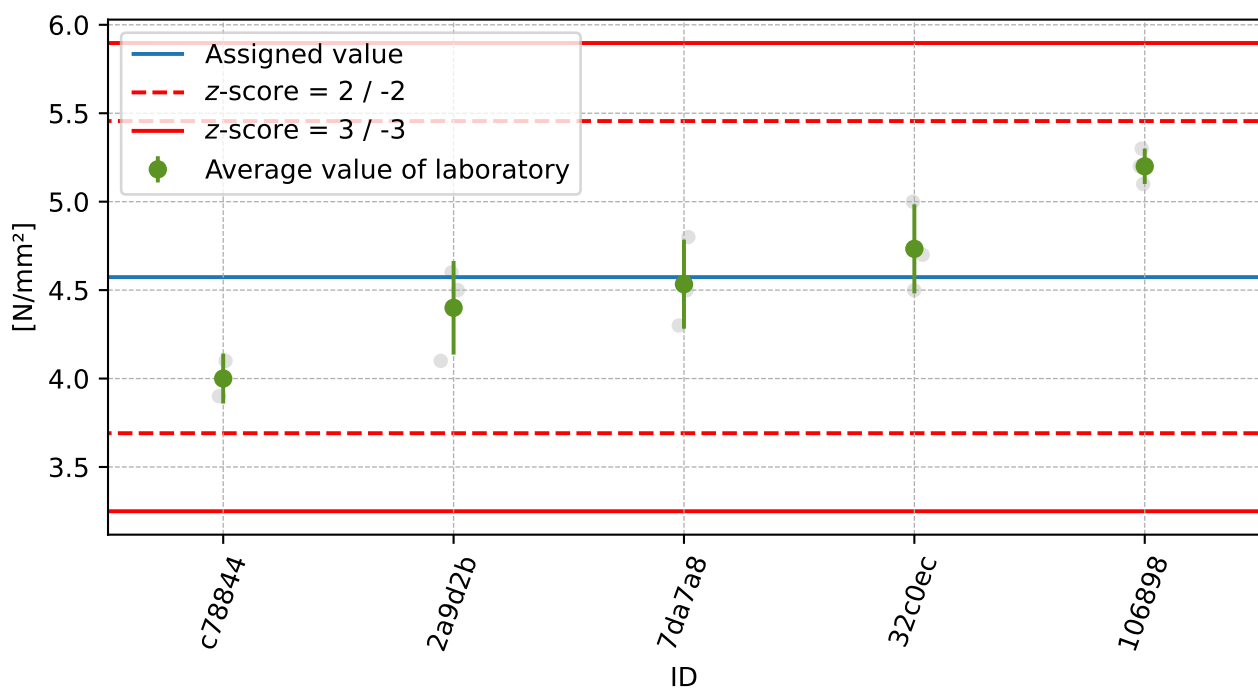


Figure 24: Average values and sample standard deviations

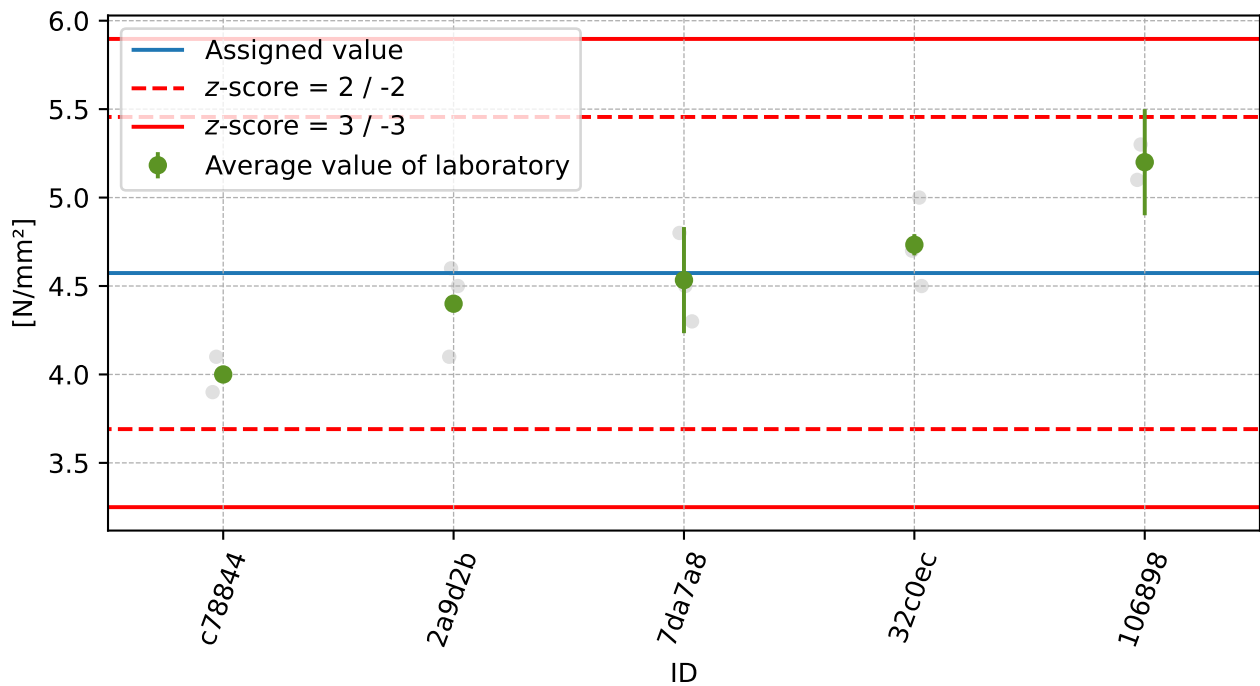


Figure 25: Average values and extended uncertainties of measurement

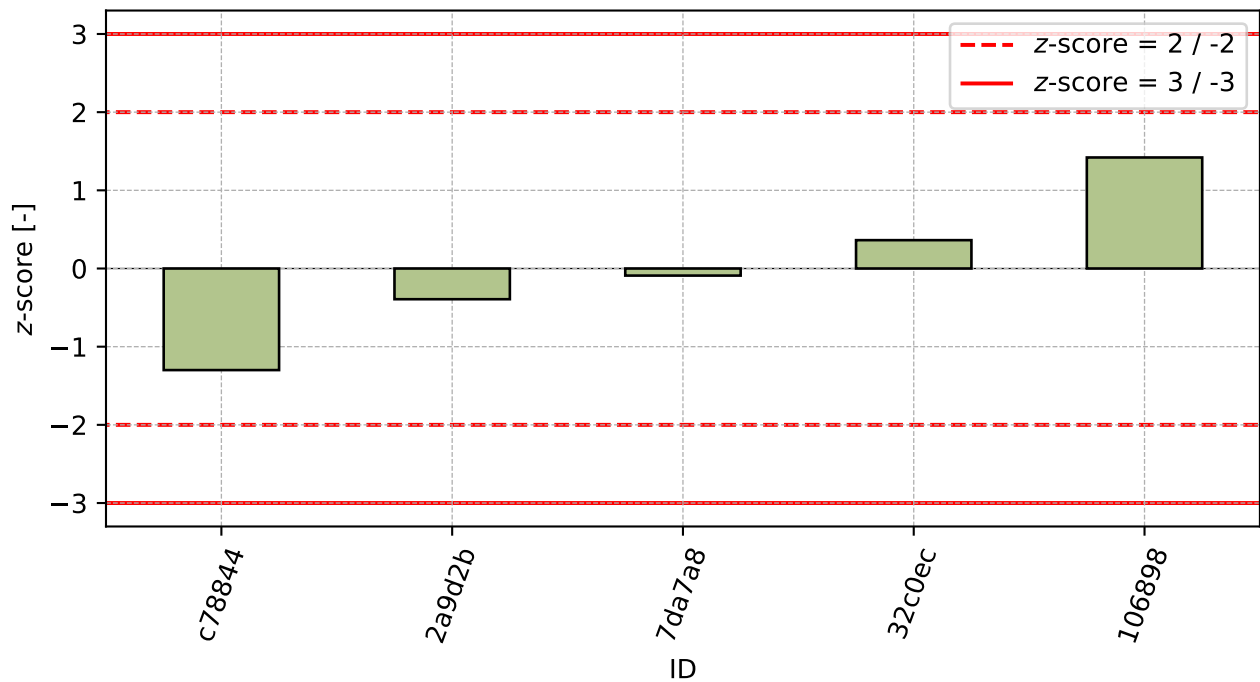


Figure 26: z-score

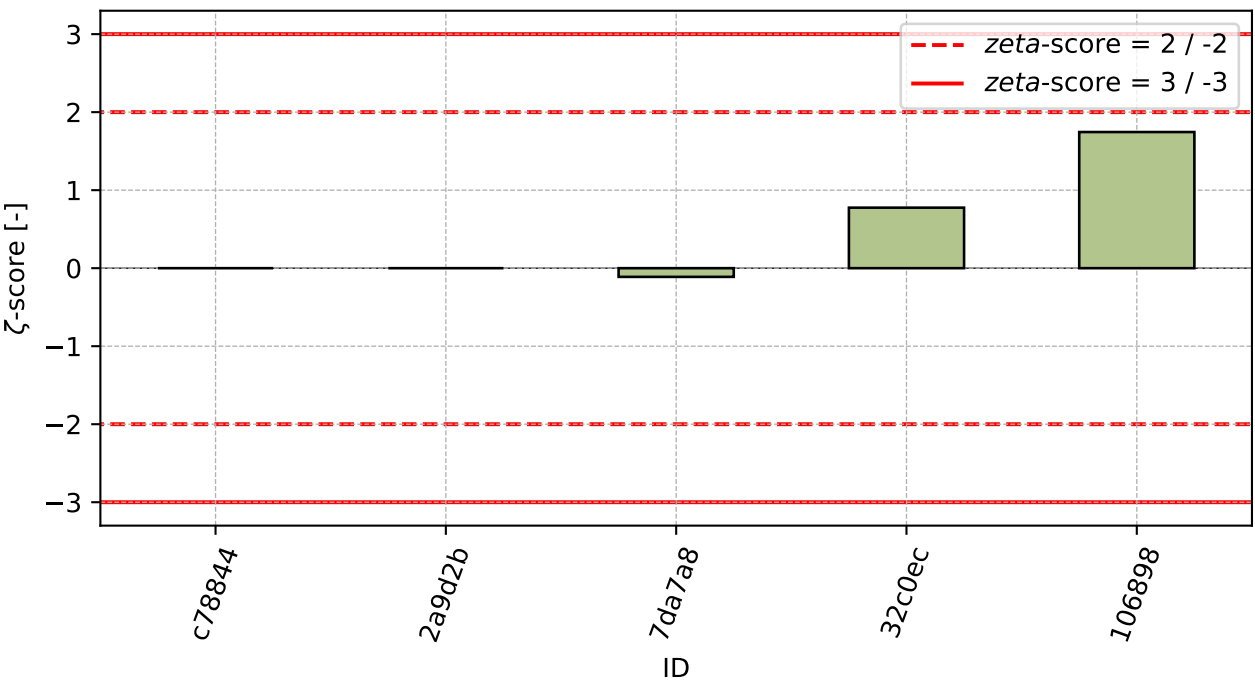


Figure 27: ζ -score

Table 12: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
c78844	-1.3	-
2a9d2b	-0.39	-
7da7a8	-0.09	-0.11
32c0ec	0.36	0.78
106898	1.42	1.75

4 Appendix – EN 12390-7 – Density of hardened concrete

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 [kg/m ³]			u_X [kg/m ³]	$\bar{x}$ [kg/m ³]	s_0 [kg/m ³]	V_X [%]
32c0ec	2295	2302	2301	6.0	2299	3.8	0.16
bfd8b0	2300	2300	2300	33.0	2300	0.0	0.00
2f10f3	2310	2300	2300	12.2	2303	5.8	0.25
c78844	2290	2310	2310	-	2303	11.5	0.50
037dc0	2314	2298	2299	56.0	2304	9.0	0.39
9a962b	2300	2310	2310	20.0	2307	5.8	0.25
3a2fcc	2308	2321	2300	6.1	2310	10.6	0.46
130a76	2310	2310	2310	13.5	2310	0.0	0.00
23e169	2312	2315	2306	10.0	2311	4.6	0.20
7da7a8	2320	2310	2310	20.0	2313	5.8	0.25
358a8f	2330	2310	2310	6.0	2317	11.5	0.50
9dd4ce	2310	2320	2320	33.0	2317	5.8	0.25
f05963	2300	2320	2340	11.0	2320	20.0	0.86
5f42be	2300	2330	2330	60.0	2320	17.3	0.75
05b4e7	2320	2320	2320	10.0	2320	0.0	0.00
6f139a	2310	2330	2330	-	2323	11.5	0.50
bd4a89	2320	2330	2320	20.0	2323	5.8	0.25
b43ca9	2330	2320	2330	60.0	2327	5.8	0.25
55eac5	2318	2331	2333	16.0	2327	8.1	0.35
15f506	2340	2320	2340	11.3	2333	11.5	0.49
e828b4	2340	2320	2350	20.0	2337	15.3	0.65
2aaaf1	2330	2340	2350	20.0	2340	10.0	0.43
dffe5d	2340	2350	2370	-	2353	15.3	0.65

4.2 The Numerical Procedure for Determining Outliers

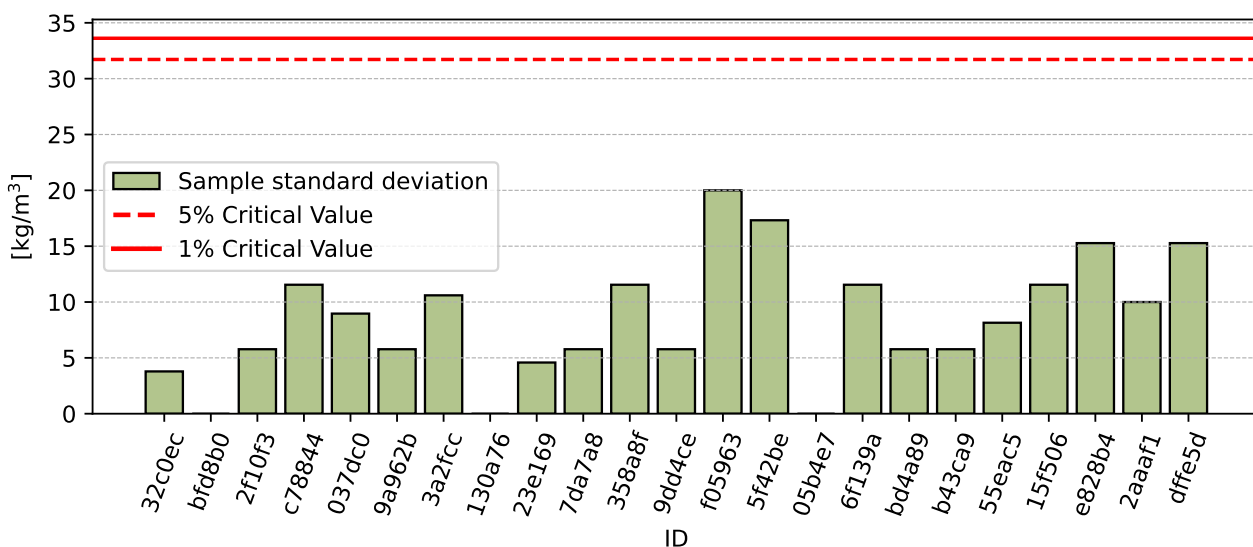


Figure 28: **Cochran's test** - sample standard deviations

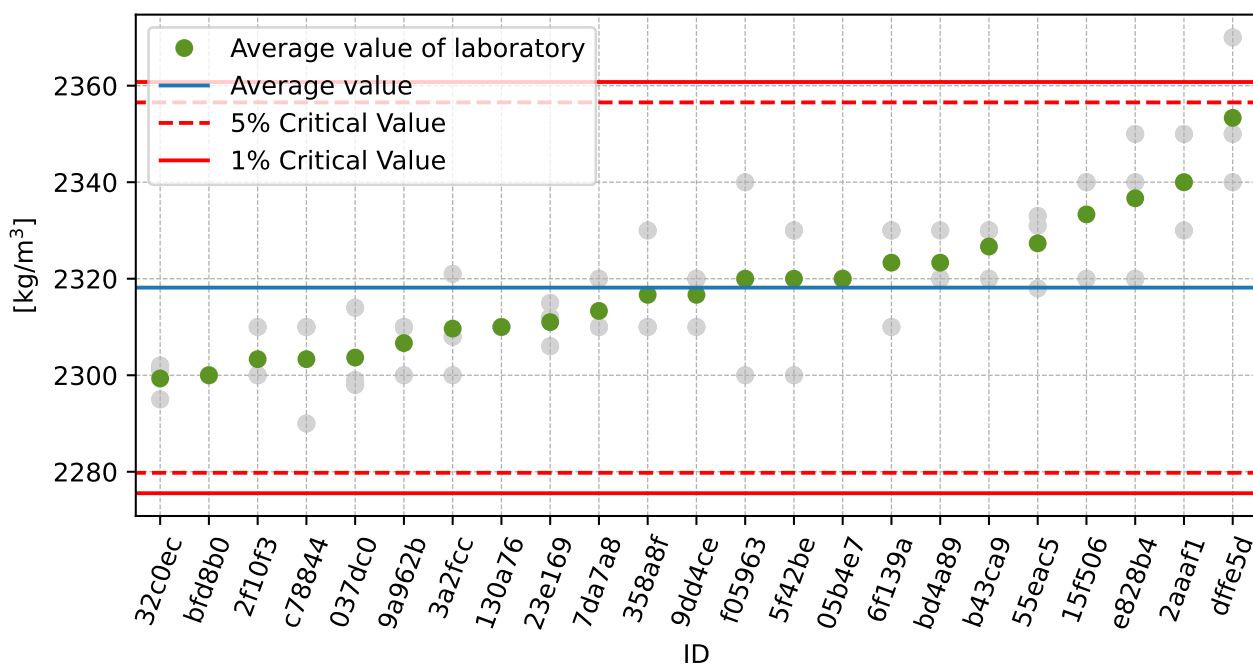


Figure 29: **Grubbs' test** - average values

4.3 Mandel's Statistics

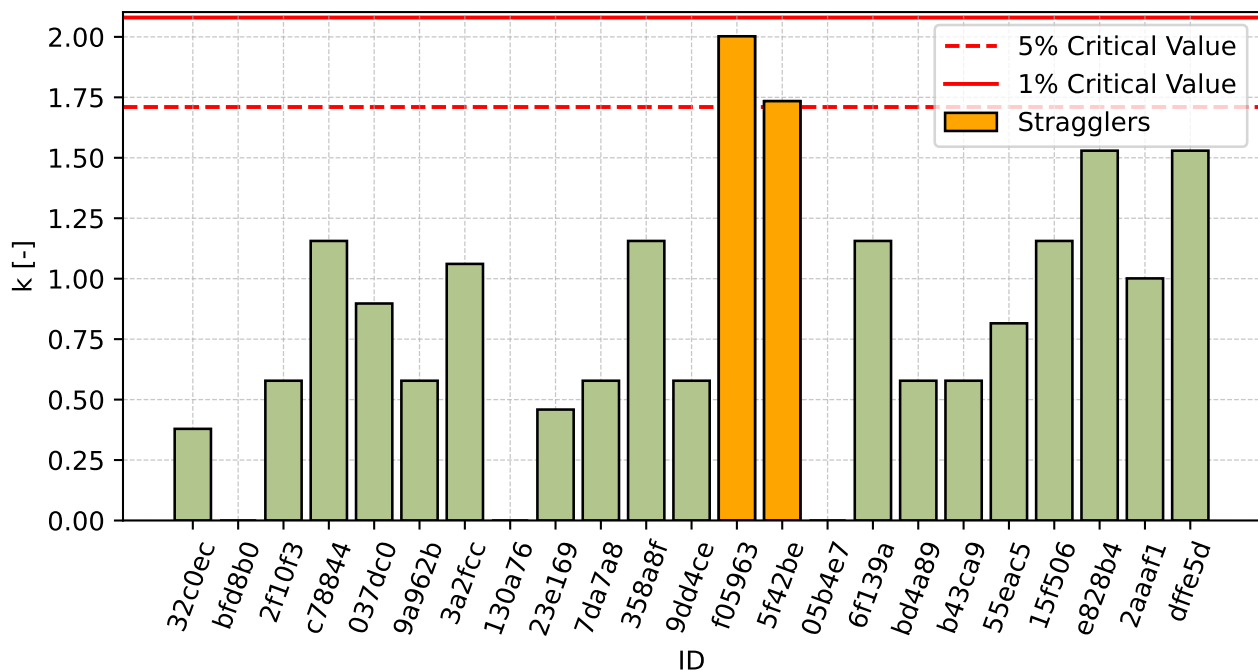


Figure 30: Intralaboratory Consistency Statistic

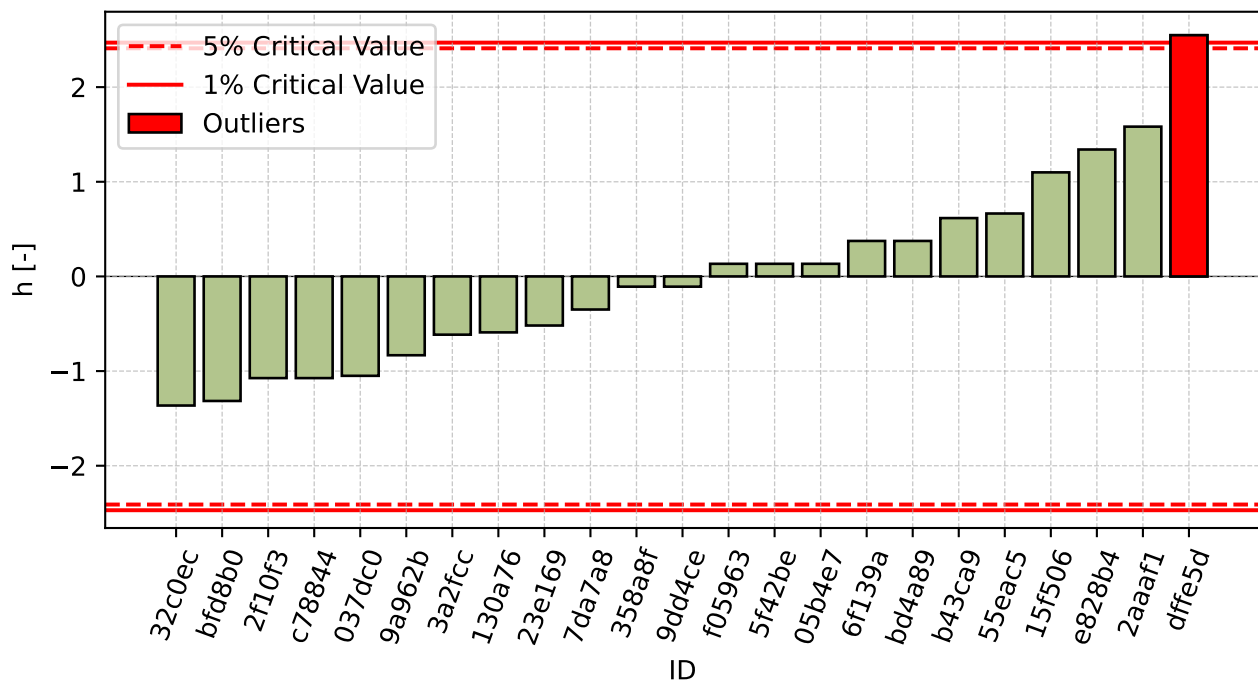


Figure 31: Interlaboratory Consistency Statistic

4.4 Descriptive statistics

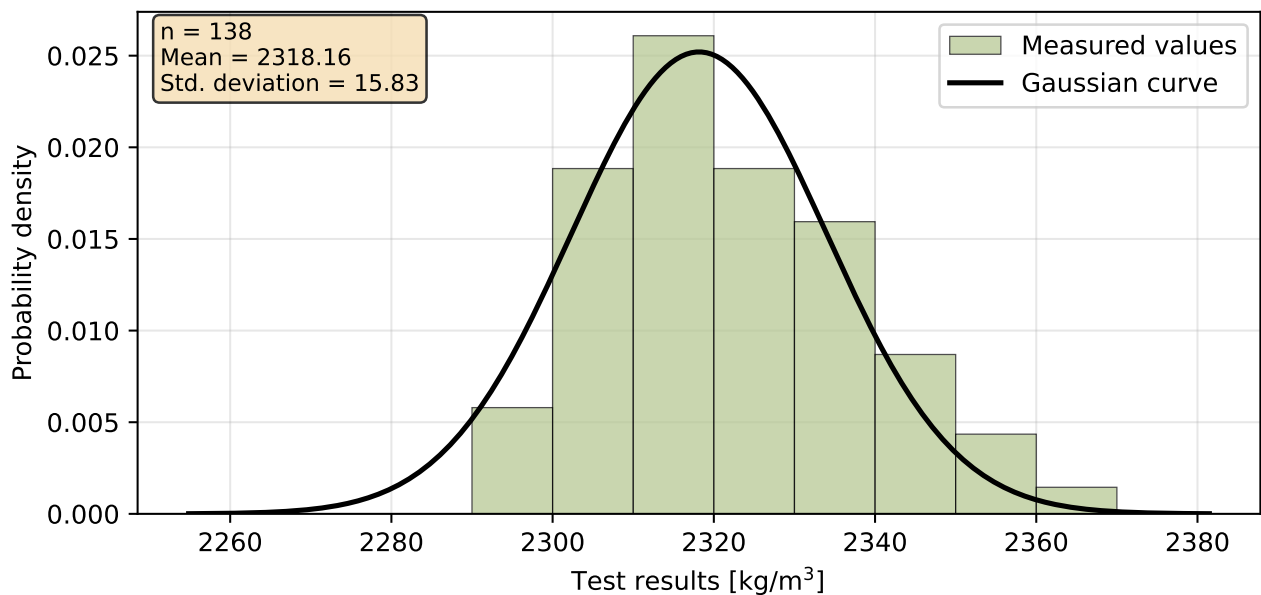


Figure 32: Histogram of all test results

Table 14: Descriptive statistics

Characteristics	[kg/m³]
Average value – $\bar{x}$	2318
Sample standard deviation – s	13.8
Assigned value – x^*	2318
Robust standard deviation – s^*	13.8
Measurement uncertainty of assigned value – u_X	2.9
p -value of normality test	0.003 [-]
Interlaboratory standard deviation – s_L	12.5
Repeatability standard deviation – s_r	10.0
Reproducibility standard deviation – s_R	16.0
Repeatability – r	28
Reproducibility – R	45

4.5 Evaluation of Performance Statistics

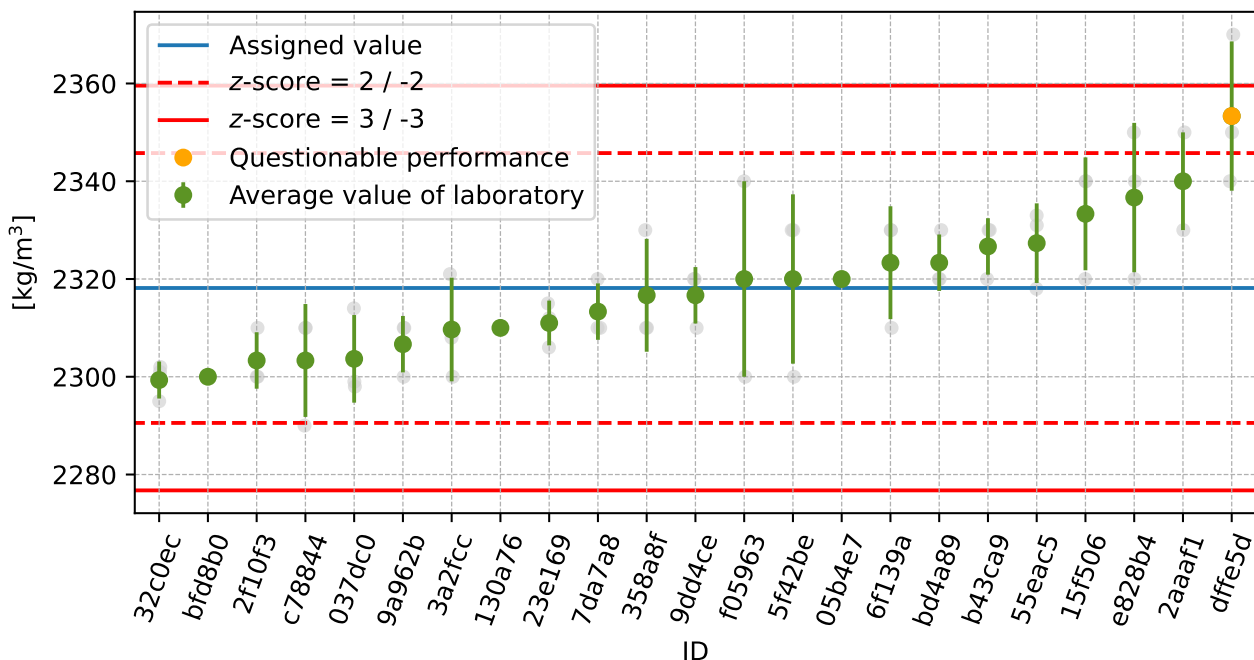


Figure 33: Average values and sample standard deviations

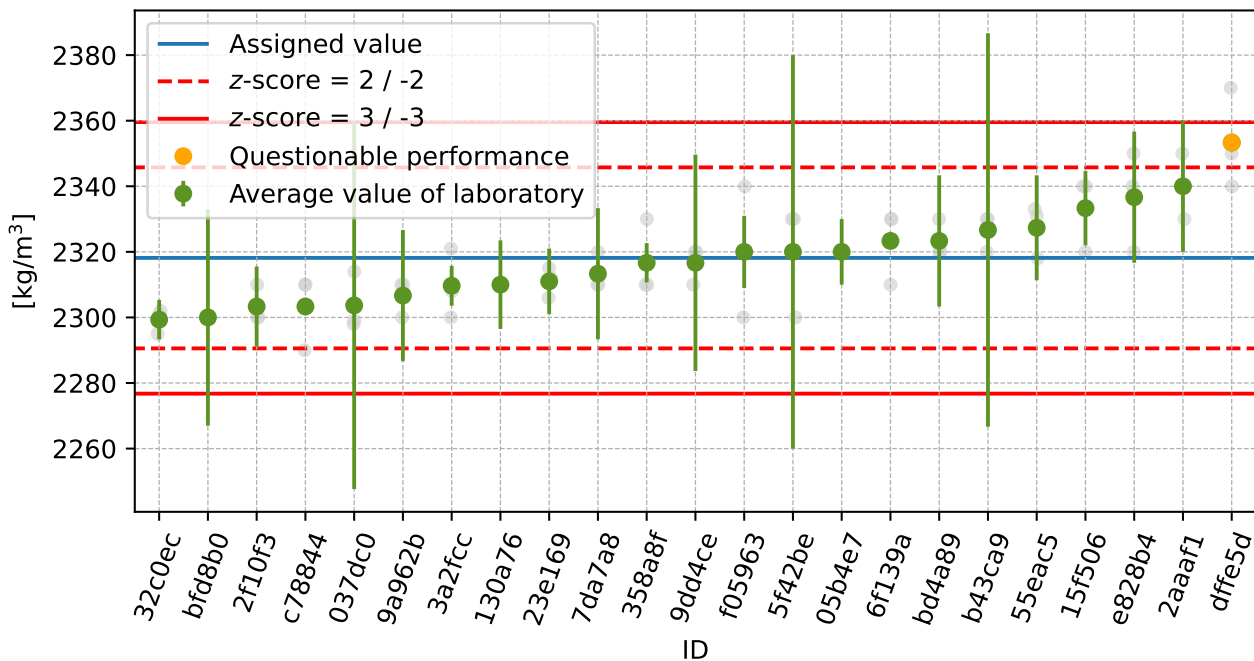


Figure 34: Average values and extended uncertainties of measurement

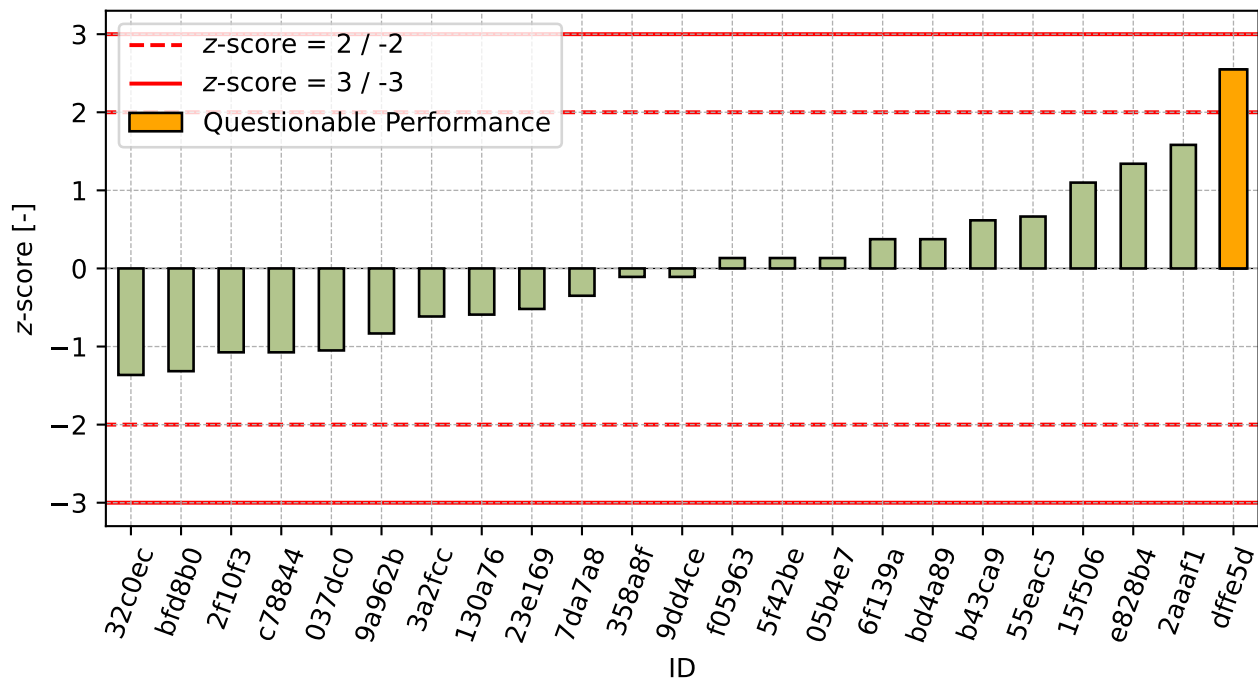


Figure 35: z-score

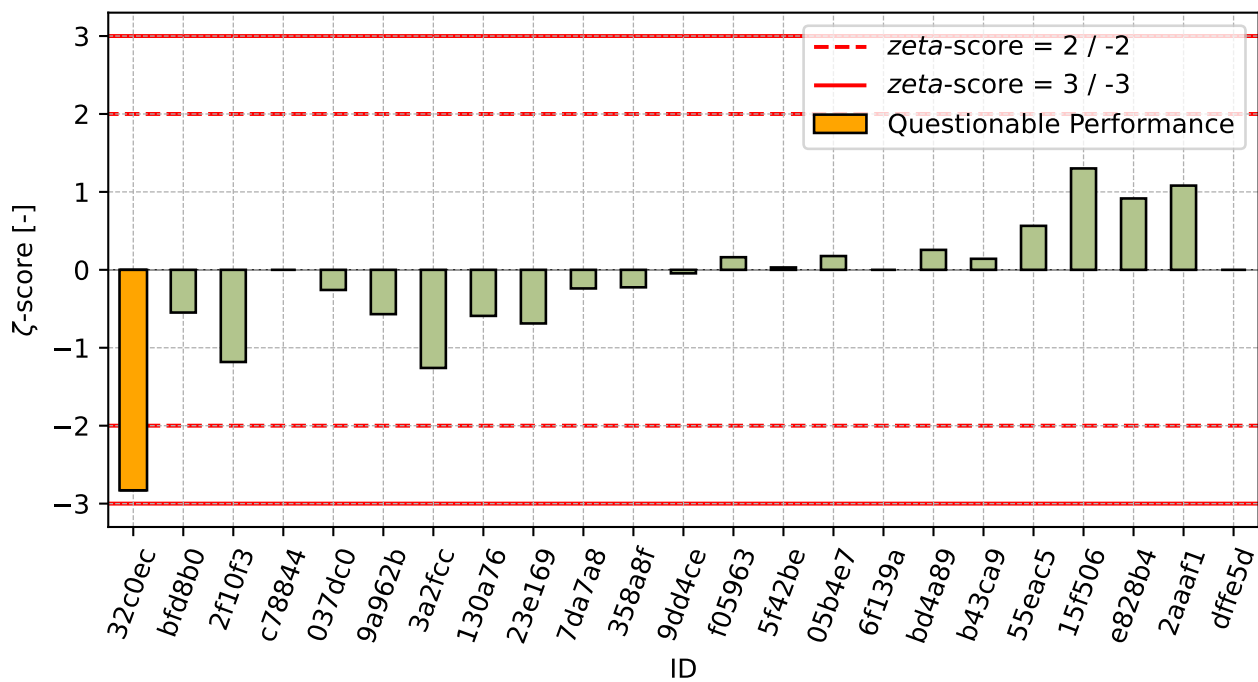


Figure 36: ζ-score

Table 15: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
32c0ec	-1.36	-2.83
bfd8b0	-1.32	-0.55
2f10f3	-1.07	-1.18
c78844	-1.07	-
037dc0	-1.05	-0.26
9a962b	-0.83	-0.57
3a2fcc	-0.62	-1.26
130a76	-0.59	-0.59
23e169	-0.52	-0.69
7da7a8	-0.35	-0.24
358a8f	-0.11	-0.22
9dd4ce	-0.11	-0.05
f05963	0.13	0.16
5f42be	0.13	0.03
05b4e7	0.13	0.18
6f139a	0.37	-
bd4a89	0.37	0.26
b43ca9	0.62	0.14
55eac5	0.66	0.56
15f506	1.1	1.3
e828b4	1.34	0.92
2aaaf1	1.58	1.08
dffe5d	2.55	-

5 Appendix – ISO 1920-10 – Determination of static modulus of elasticity in compression

5.1 Test results

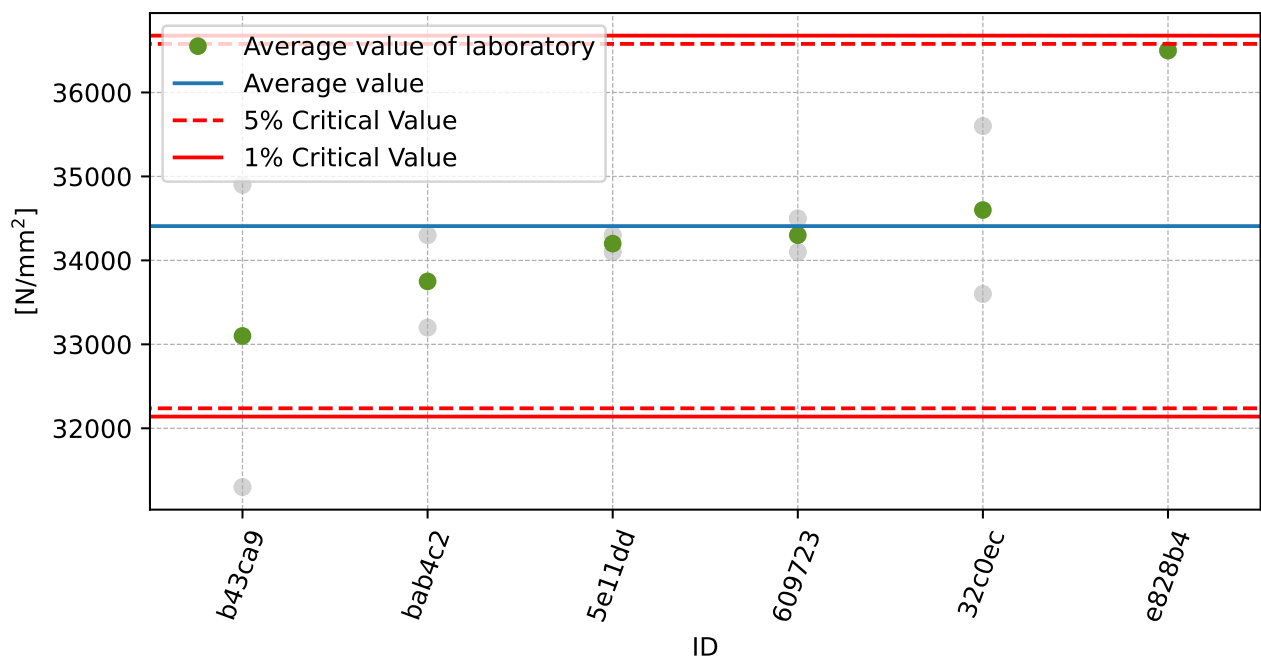
Table 16: Test results - ordered by average value. Outliers are marked by red color. u_x - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_x - variation coefficient

ID	Test results [N/mm ²]		u_x [N/mm ²]	$\bar{x}$ [N/mm ²]	s_0 [N/mm ²]	V_x [%]
b43ca9	31300	34900	860.0	33100	2545.6	7.69
bab4c2	33200	34300	1800.0	33750	777.8	2.30
5e11dd	34300	34100	1700.0	34200	141.4	0.41
609723	34500	34100	1900.0	34300	282.8	0.82
32c0ec	35600	33600	690.0	34600	1414.2	4.09
e828b4	36500	36500	1200.0	36500	0.0	0.00

5.2 The Numerical Procedure for Determining Outliers



Figure 37: **Cochran's test** - sample standard deviations

Figure 38: **Grubbs' test** - average values

5.3 Mandel's Statistics

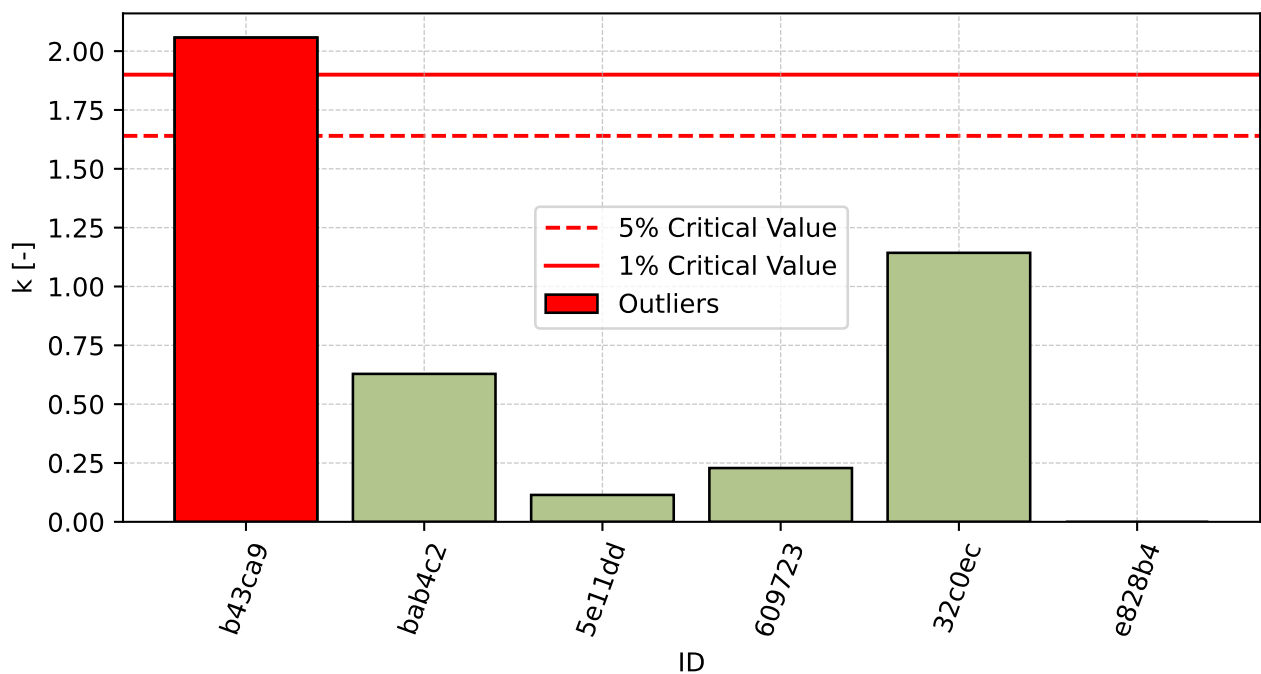


Figure 39: Intralaboratory Consistency Statistic

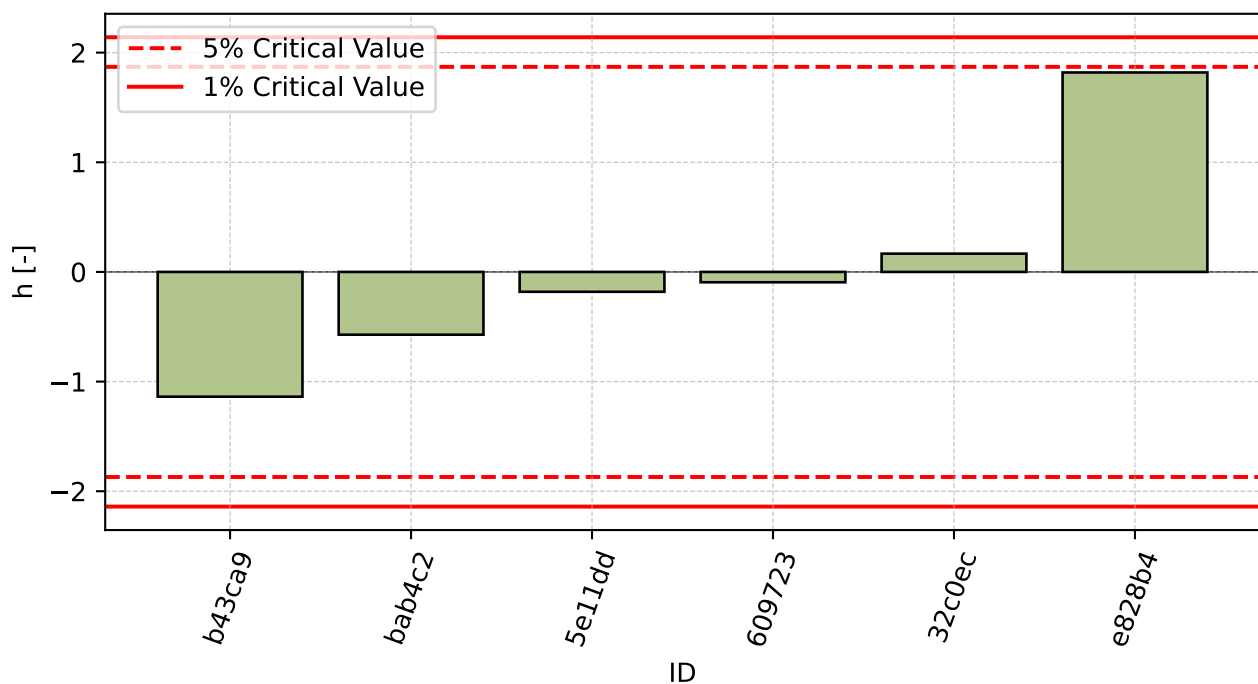


Figure 40: Interlaboratory Consistency Statistic

5.4 Descriptive statistics

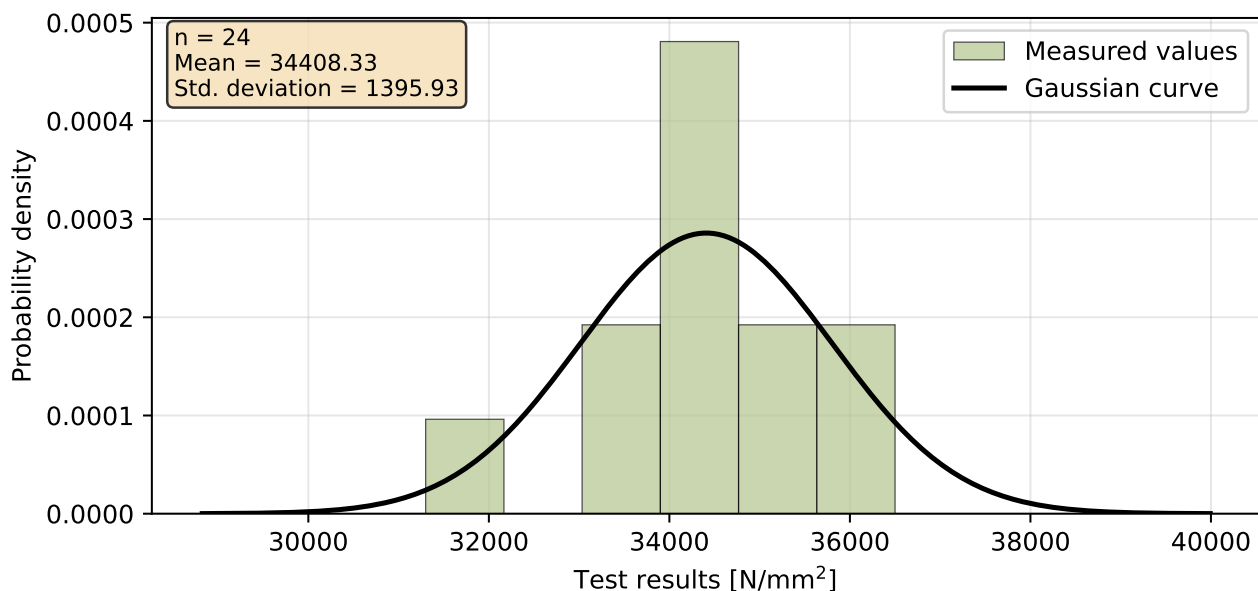


Figure 41: Histogram of all test results

Table 17: Descriptive statistics

Characteristics	[N/mm ²]
Average value – $\bar{x}$	34408
Sample standard deviation – s	1150.0
Assigned value – x^*	34408
Robust standard deviation – s^*	1150.0
Measurement uncertainty of assigned value – u_X	469.5
p -value of normality test	0.436 [-]
Interlaboratory standard deviation – s_L	746.3
Repeatability standard deviation – s_r	1237.3
Reproducibility standard deviation – s_R	1444.9
Repeatability – r	3464
Reproducibility – R	4046

5.5 Evaluation of Performance Statistics

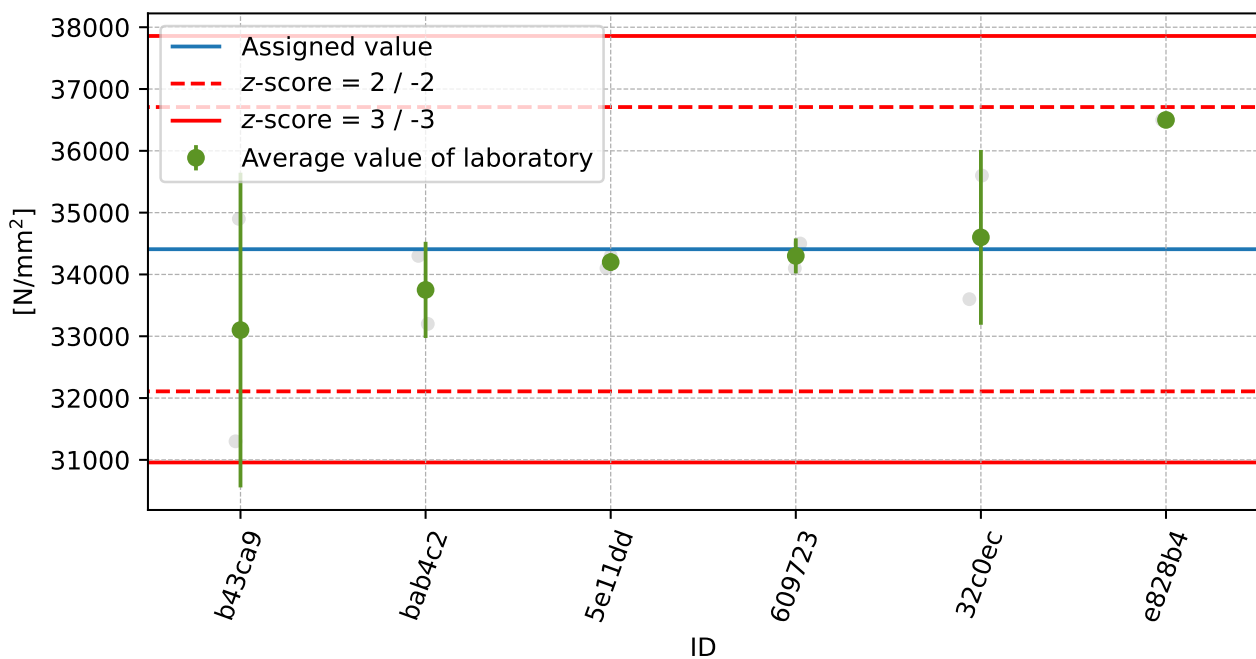


Figure 42: Average values and sample standard deviations

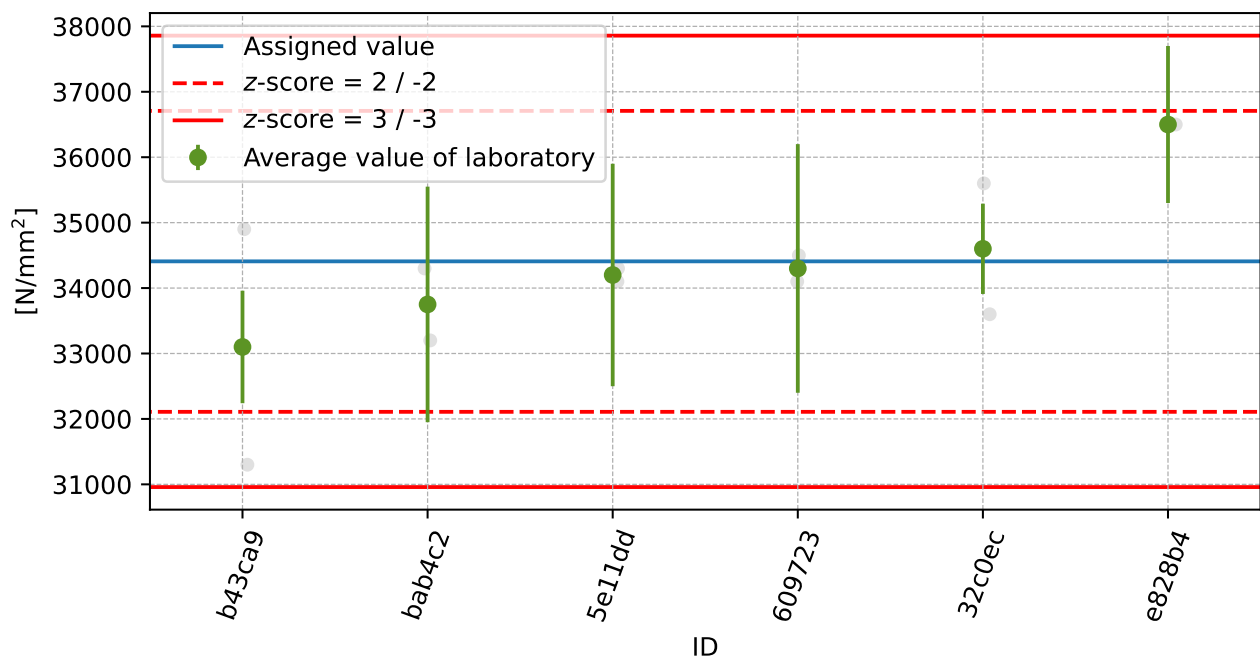


Figure 43: Average values and extended uncertainties of measurement

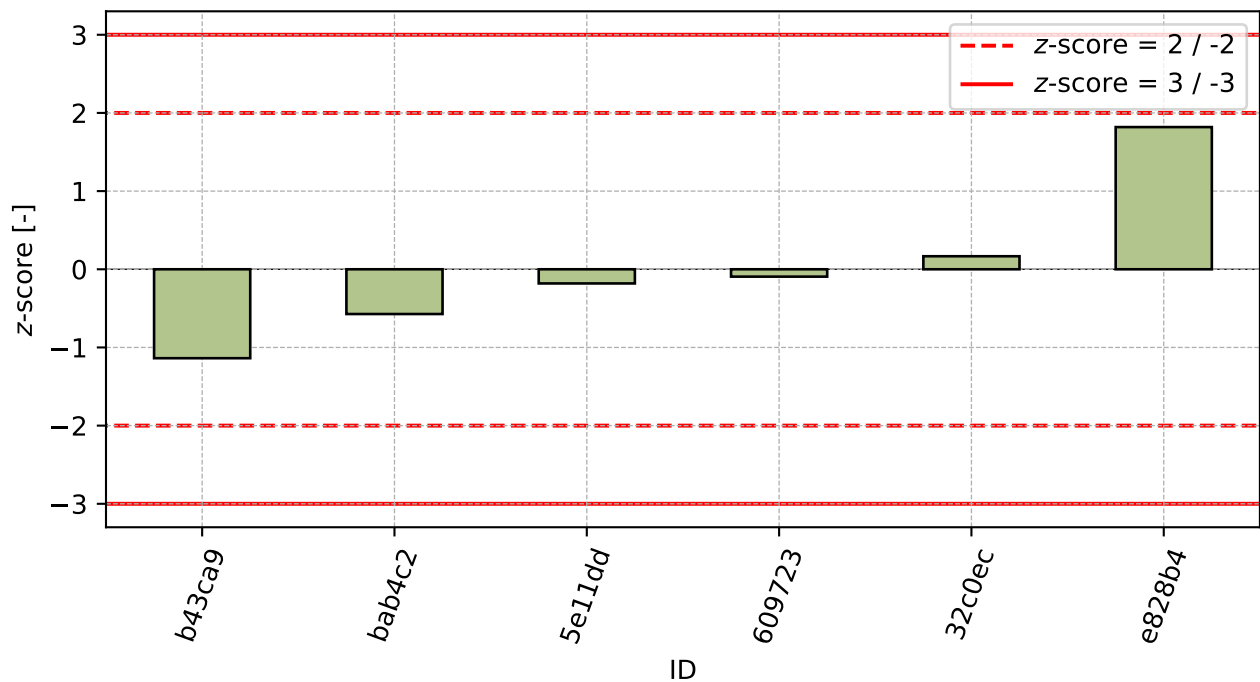


Figure 44: z-score

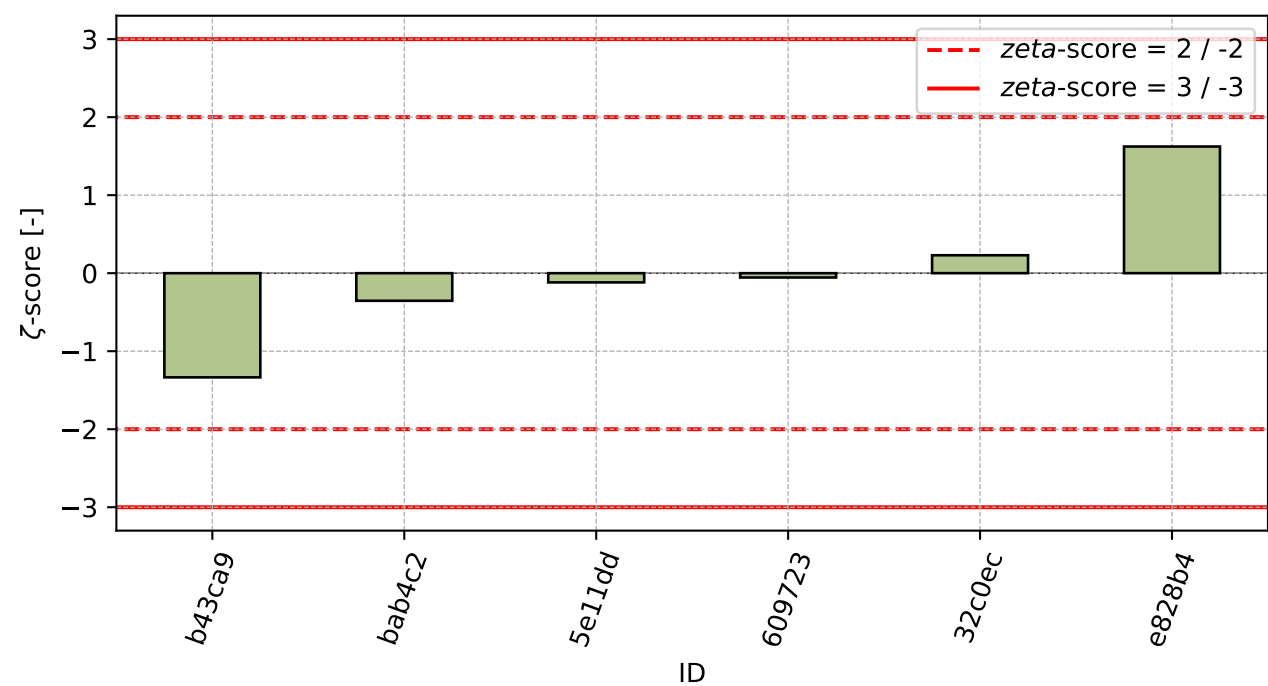


Figure 45: ζ -score

Table 18: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
b43ca9	-1.14	-1.34
bab4c2	-0.57	-0.35
5e11dd	-0.18	-0.12
609723	-0.09	-0.06
32c0ec	0.17	0.23
e828b4	1.82	1.62

6 Appendix – EN 12390-13, method A – Determination of secant modulus of elasticity in compression

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

7 Appendix – EN 12390-13, method B – Determination of secant modulus of elasticity in compression

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

8 Appendix – EN 12504-4, ČSN 731371 – Non-destructive testing of concrete

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

9 Appendix – ČSN 731373, EN 12504-2 – Determination of rebound number

9.1 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 [-]			u_X [-]	$\bar{x}$ [-]	s_0 [-]	V_X [%]
5a3b2f	24	25	27	-	25	1.5	6.03
1ef433	33	37	37	1.7	36	2.3	6.47
bd4a89	41	38	40	5.0	40	1.5	3.85
3a2fcc	40	39	41	0.6	40	1.0	2.50
3a2fcc	40	39	41	0.6	40	1.0	2.50
106898	40	42	42	4.0	41	1.2	2.79
29cd71	42	43	43	-	43	0.6	1.35
9cd794	43	42	43	-	43	0.6	1.35
7da7a8	42	43	45	4.0	43	1.5	3.53
13222d	44	42	44	3.0	43	1.2	2.66
55eac5	43	44	43	1.3	43	0.6	1.33

9.2 The Numerical Procedure for Determining Outliers

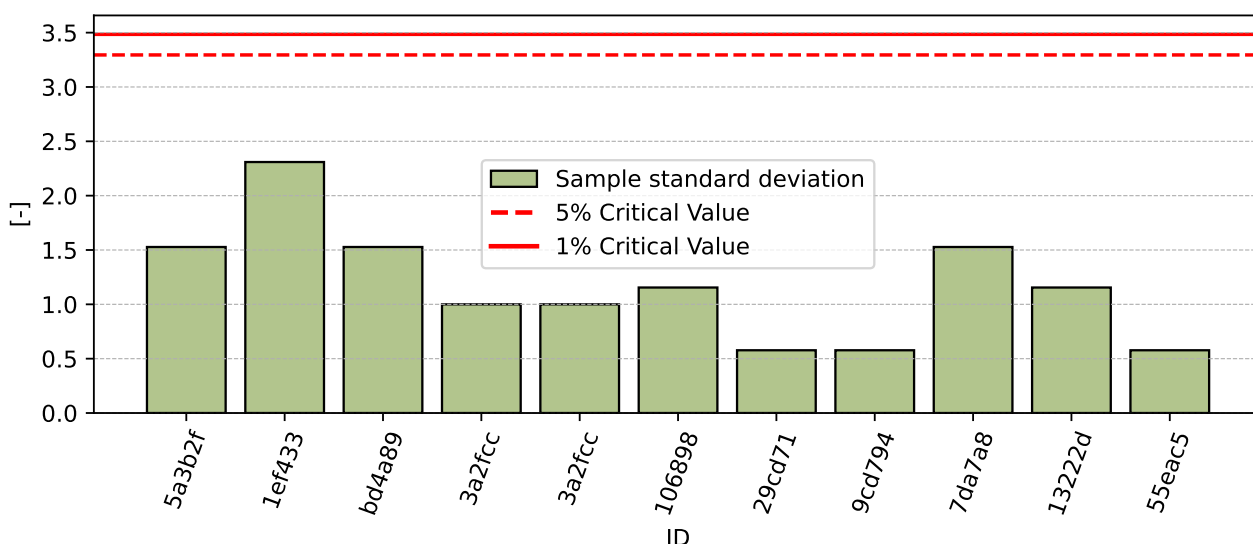
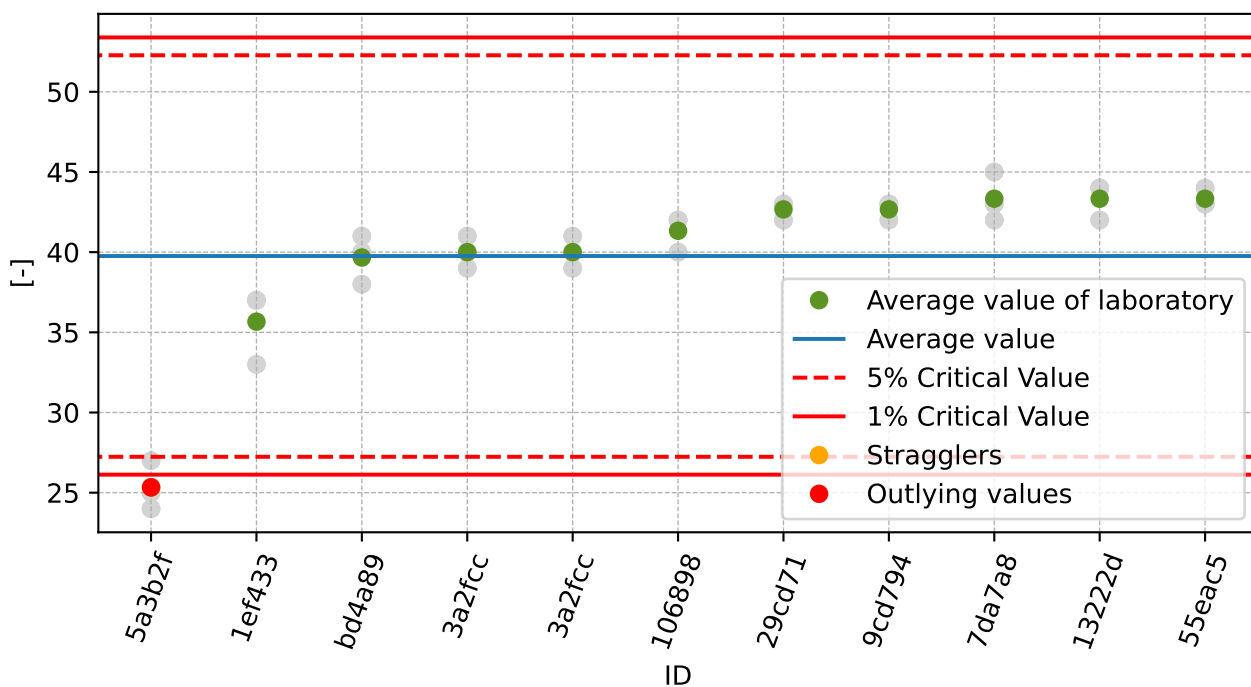
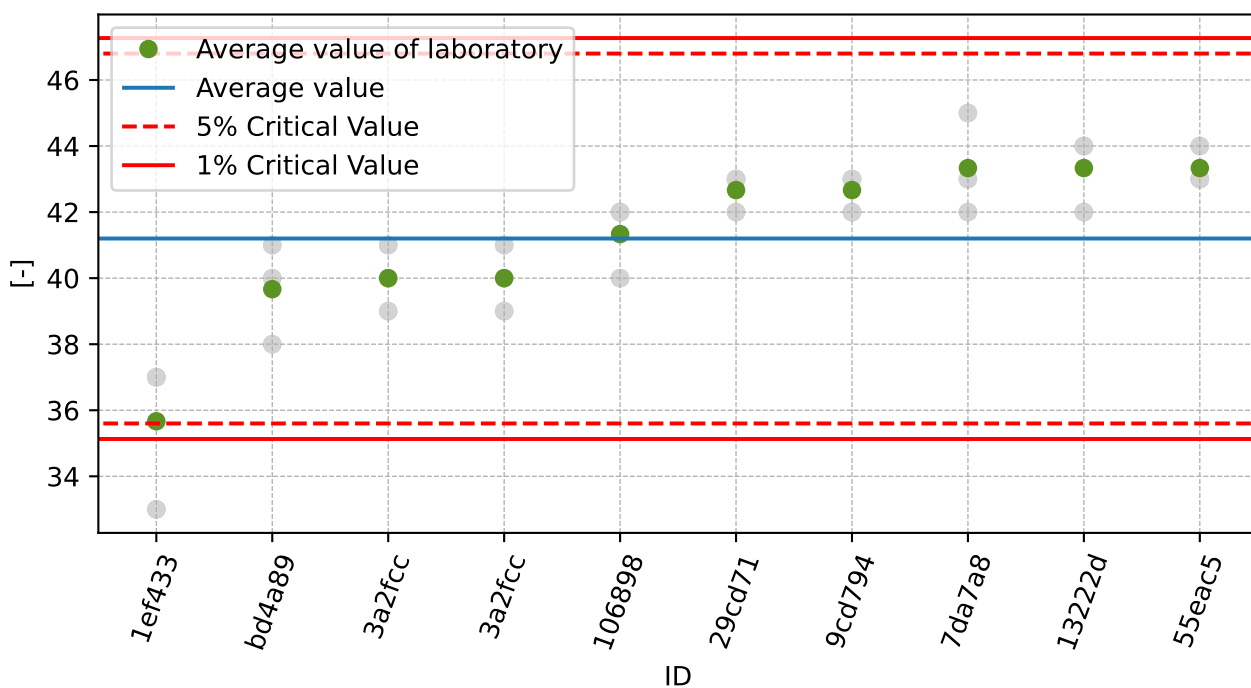


Figure 46: Cochran's test - sample standard deviations

Figure 47: **Grubbs' test** - average valuesFigure 48: **Grubbs' test** - average values without outliers

9.3 Mandel's Statistics

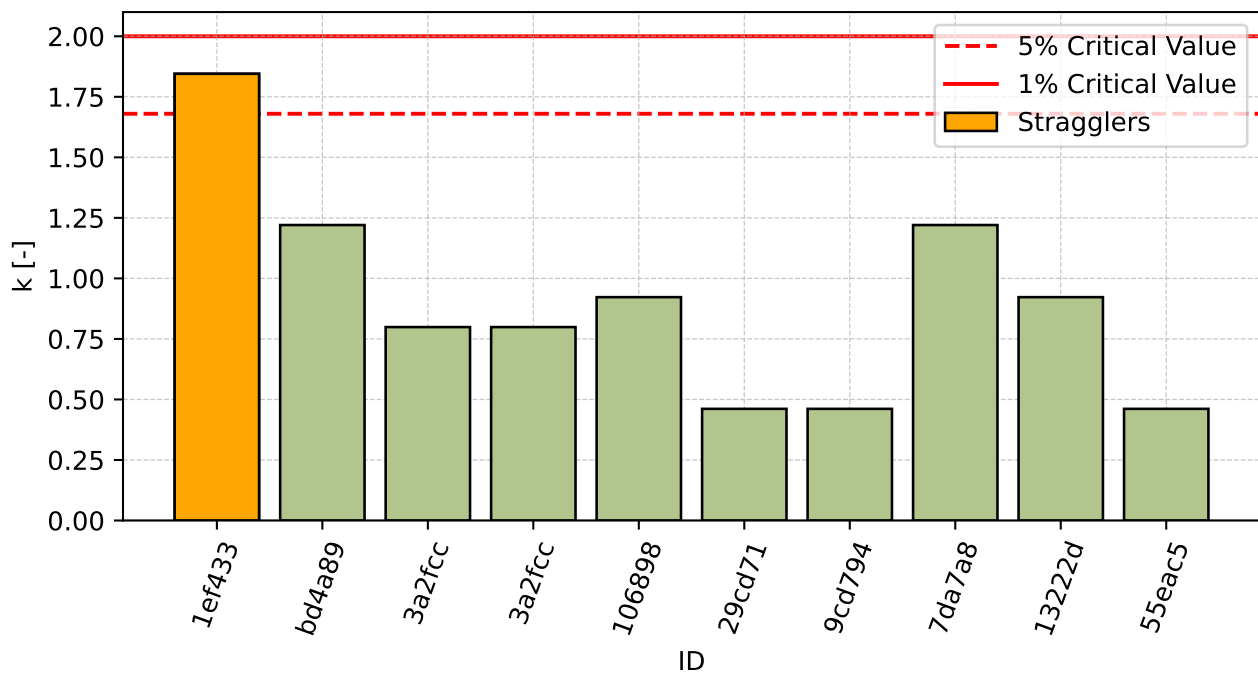


Figure 49: Intralaboratory Consistency Statistic

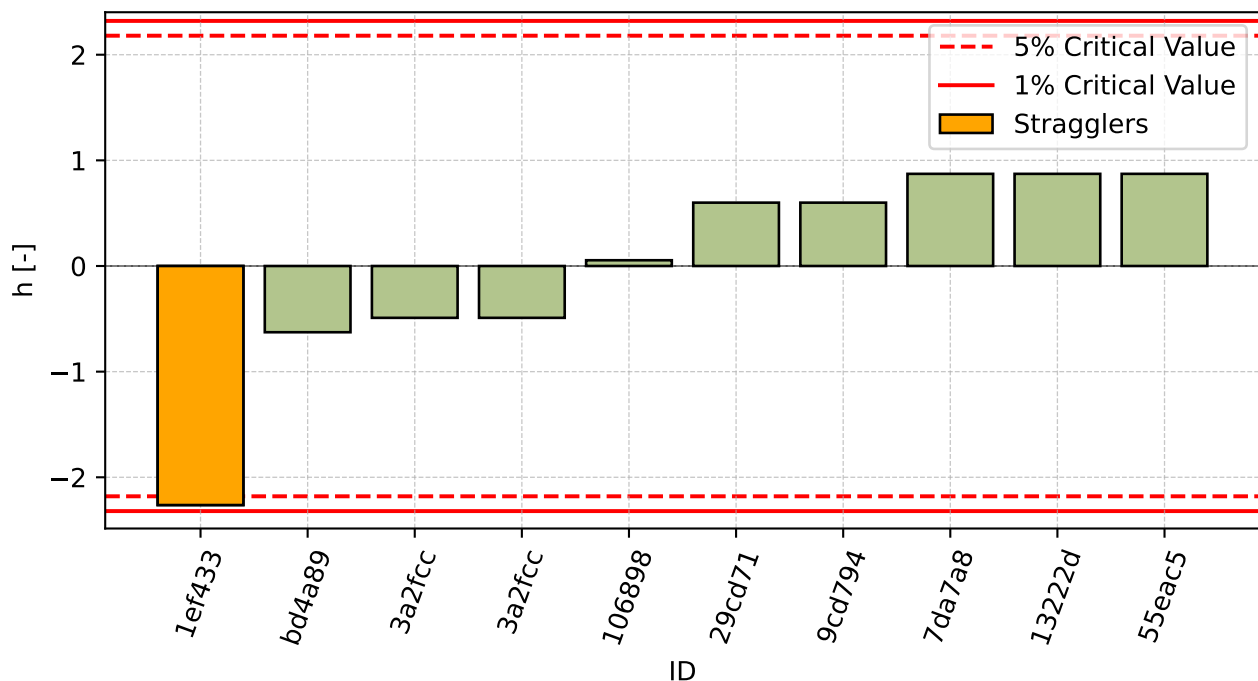


Figure 50: Interlaboratory Consistency Statistic

9.4 Descriptive statistics

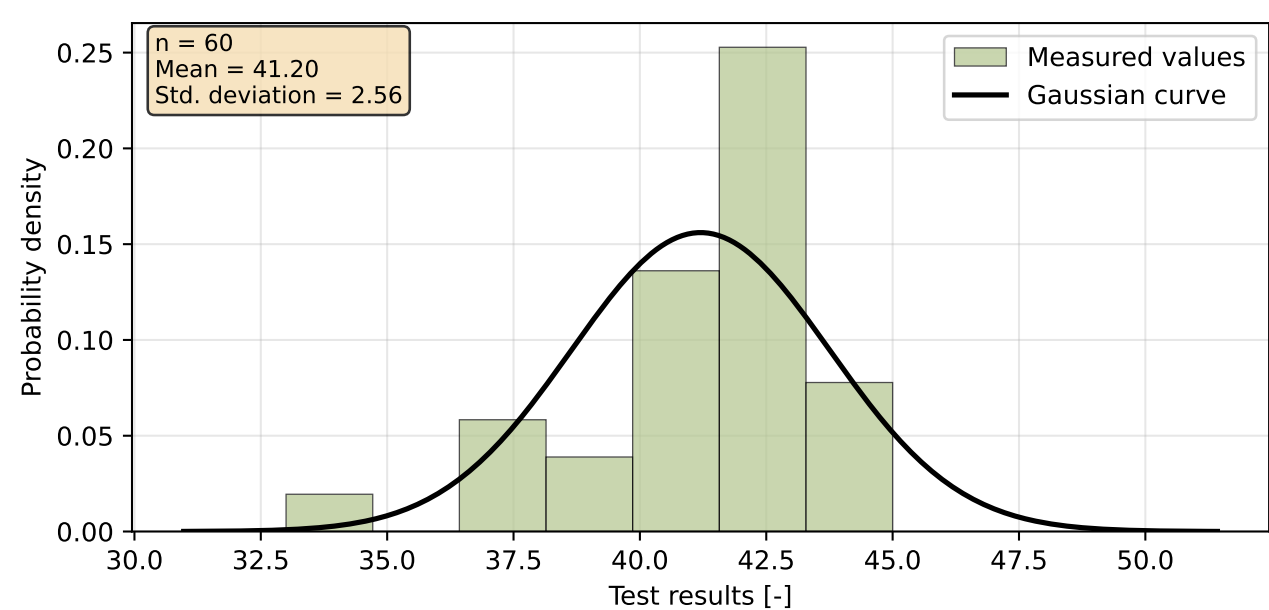


Figure 51: Histogram of all test results

Table 20: Descriptive statistics

Characteristics	[-]
Average value – $\bar{x}$	41
Sample standard deviation – s	2.4
Assigned value – x^*	41
Robust standard deviation – s^*	2.4
Measurement uncertainty of assigned value – u_x	0.8
p -value of normality test	0.008 [-]

9.5 Evaluation of Performance Statistics

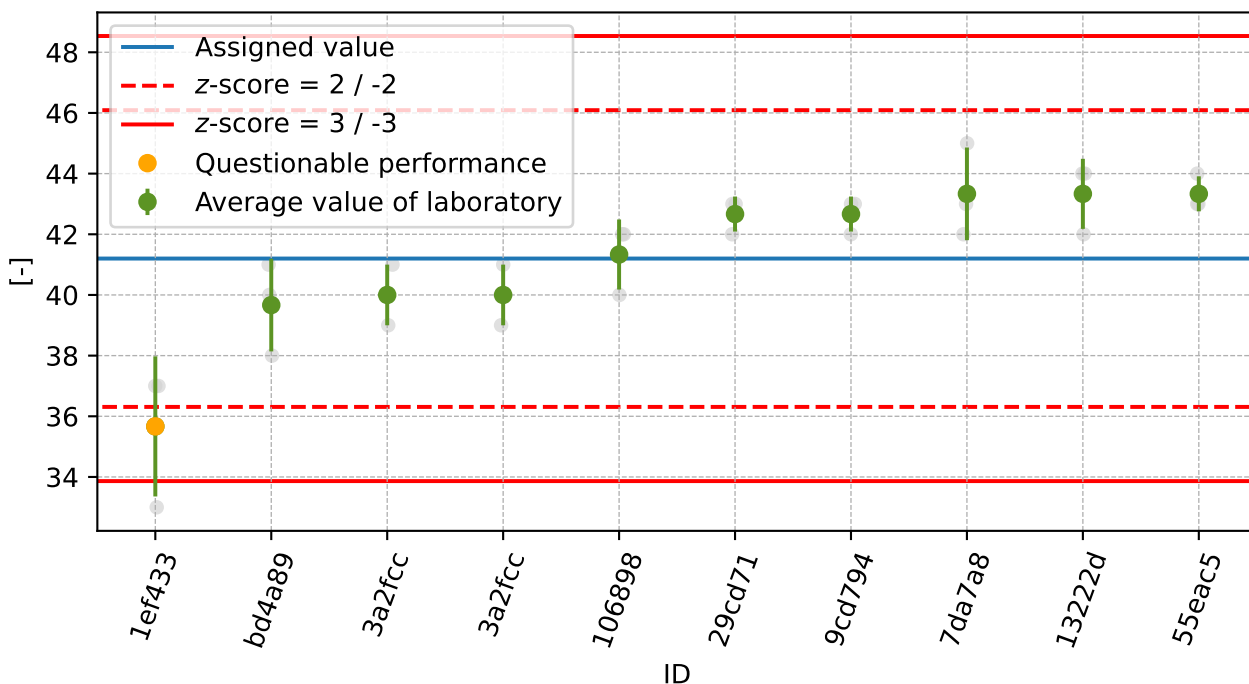


Figure 52: Average values and sample standard deviations

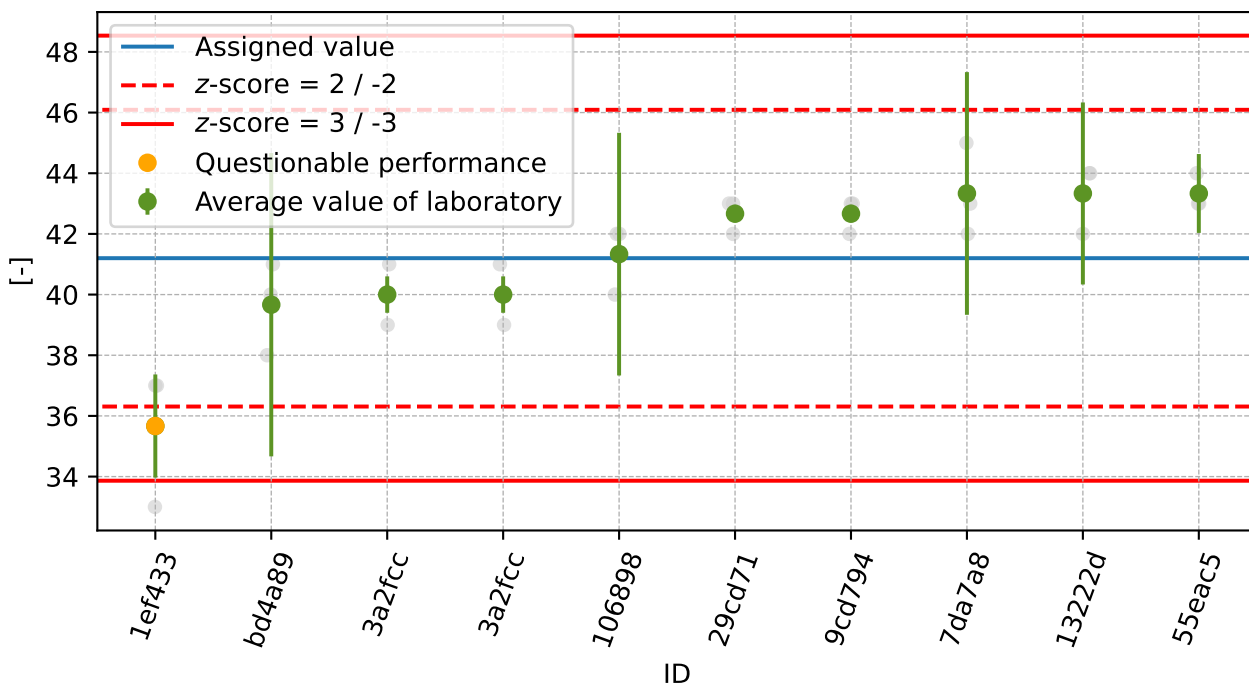


Figure 53: Average values and extended uncertainties of measurement

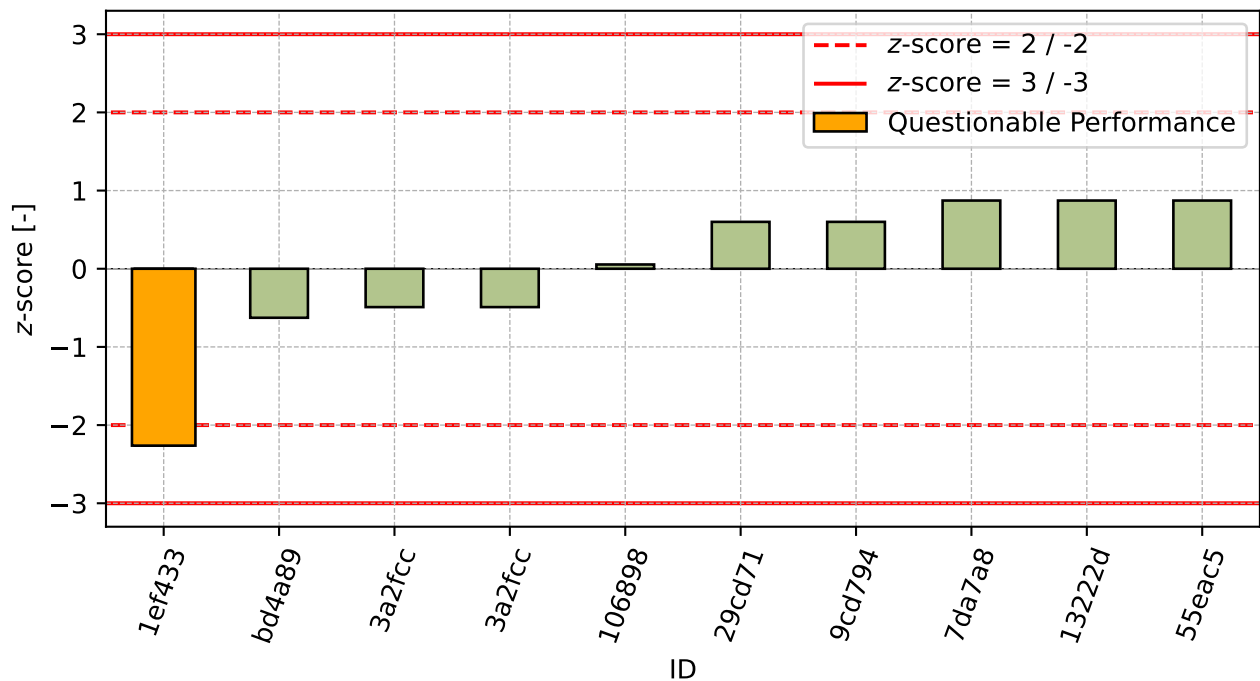


Figure 54: z-score

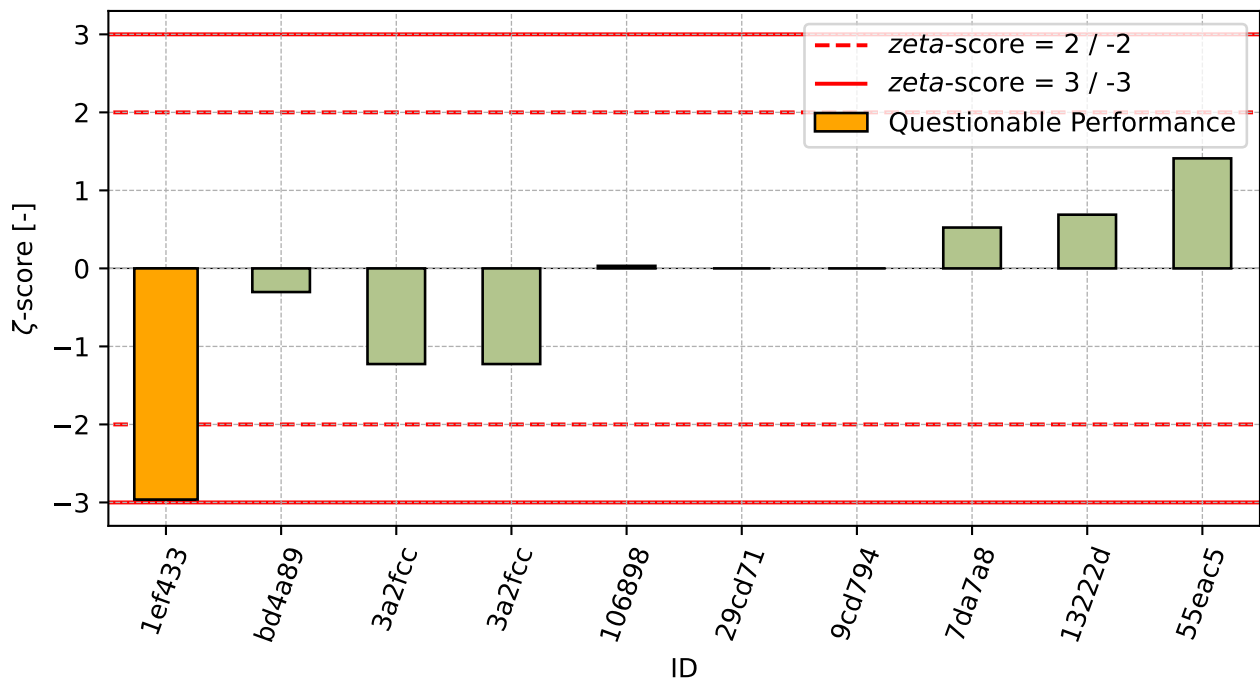


Figure 55: ζ-score

Table 21: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
1ef433	-2.26	-2.96
bd4a89	-0.63	-0.3
3a2fcc	-0.49	-1.23
3a2fcc	-0.49	-1.23
106898	0.05	0.03
29cd71	0.6	-
9cd794	0.6	-
7da7a8	0.87	0.52
13222d	0.87	0.69
55eac5	0.87	1.41

10 Appendix – EN 1542, ČSN 736242, Appendix B – Measurement of bond strength by pull-off

10.1 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 [MPa]					u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
b86303	2.22	1.80	2.30	1.75	2.00	-	2.01	0.245	12.16
dffe5d	2.60	2.70	3.00	3.00	2.60	-	2.78	0.205	7.37
b43ca9	3.18	3.12	2.26	3.51	3.05	0.090	3.02	0.462	15.28
75dfe7	3.60	3.40	3.10	3.10	3.50	0.200	3.34	0.230	6.89
5511ca	4.10	3.50	3.00	2.70	3.50	0.500	3.36	0.537	15.97
3a2fcc	3.68	3.31	3.10	3.50	3.24	0.102	3.37	0.227	6.75
05b4e7	3.30	3.20	3.00	3.30	4.10	0.300	3.38	0.421	12.45
eb39d7	3.29	3.56	3.53	3.27	3.38	0.120	3.41	0.134	3.93
358a8f	3.40	3.90	3.20	3.70	3.20	0.100	3.48	0.311	8.95
7da7a8	3.95	4.15	3.70	3.69	3.73	0.570	3.84	0.201	5.24

10.2 The Numerical Procedure for Determining Outliers

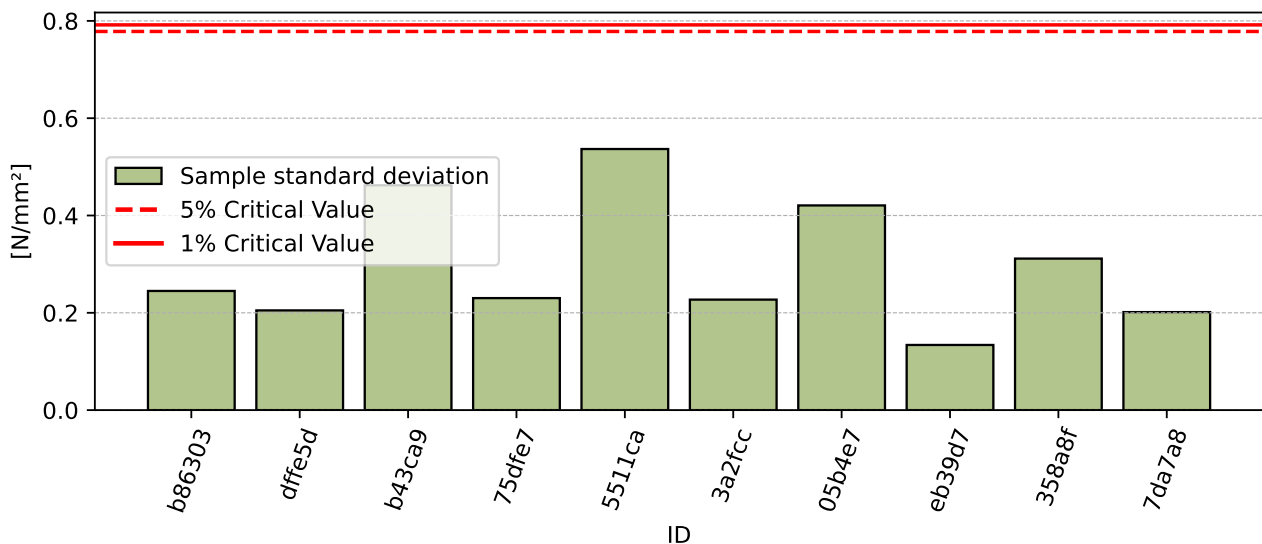
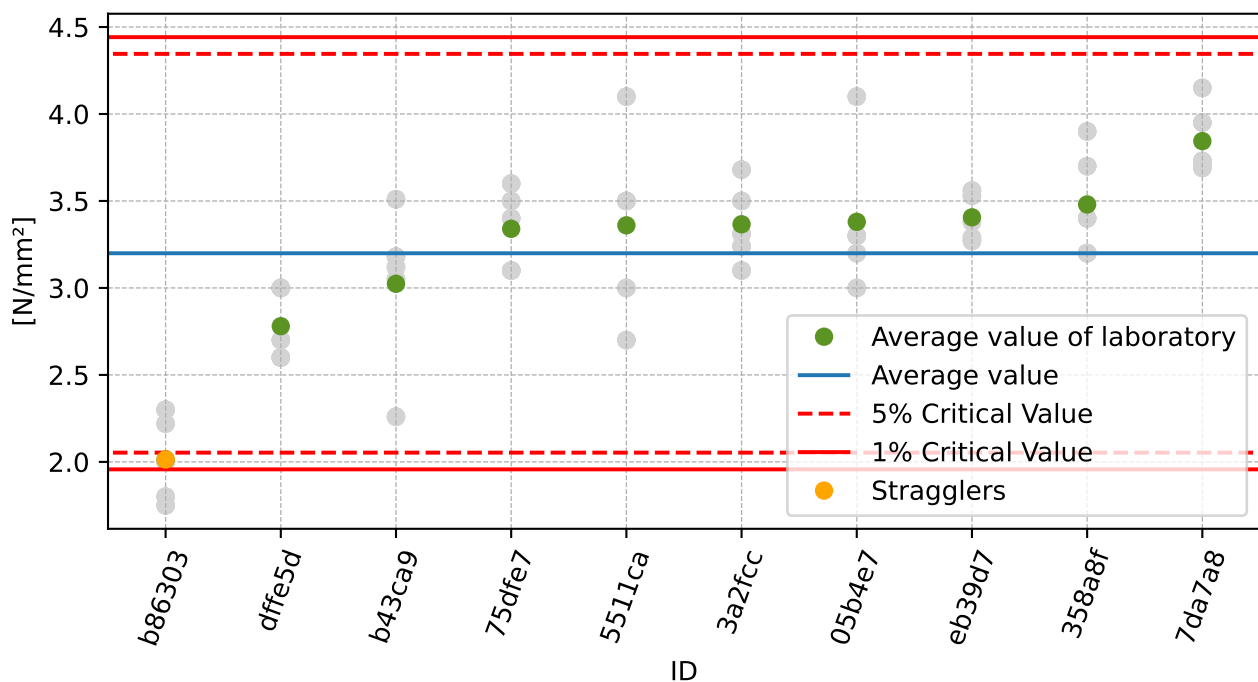


Figure 56: **Cochran's test** - sample standard deviations

Figure 57: **Grubbs' test** - average values

10.3 Mandel's Statistics

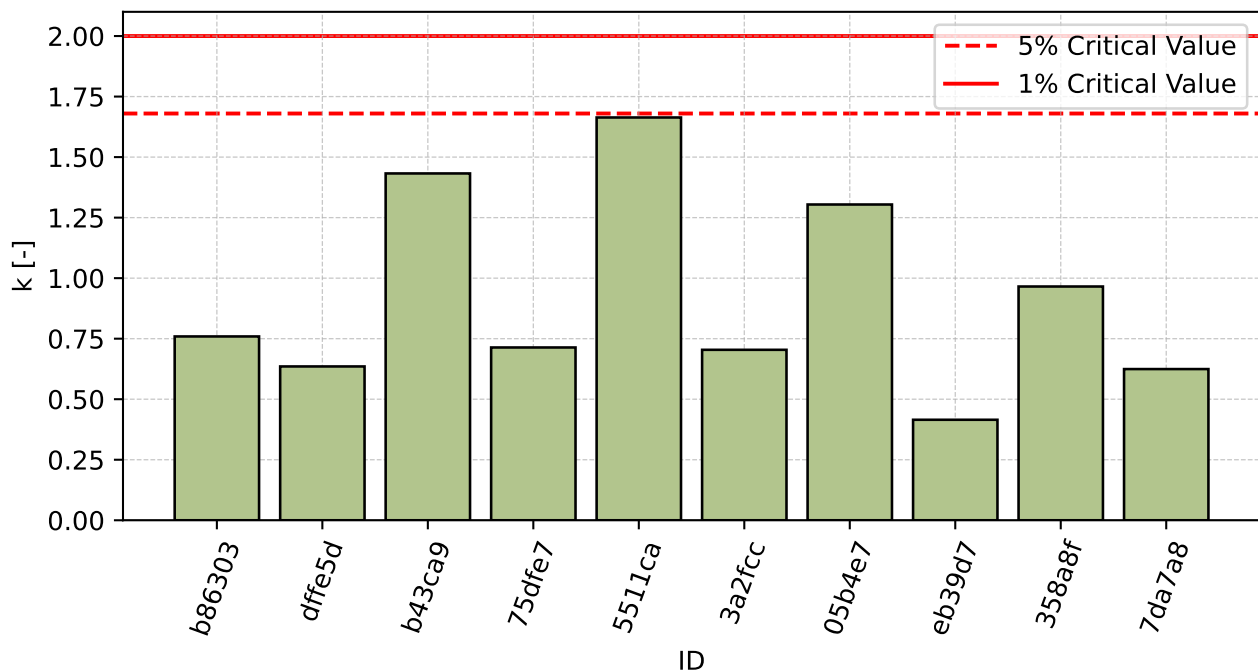


Figure 58: Intralaboratory Consistency Statistic

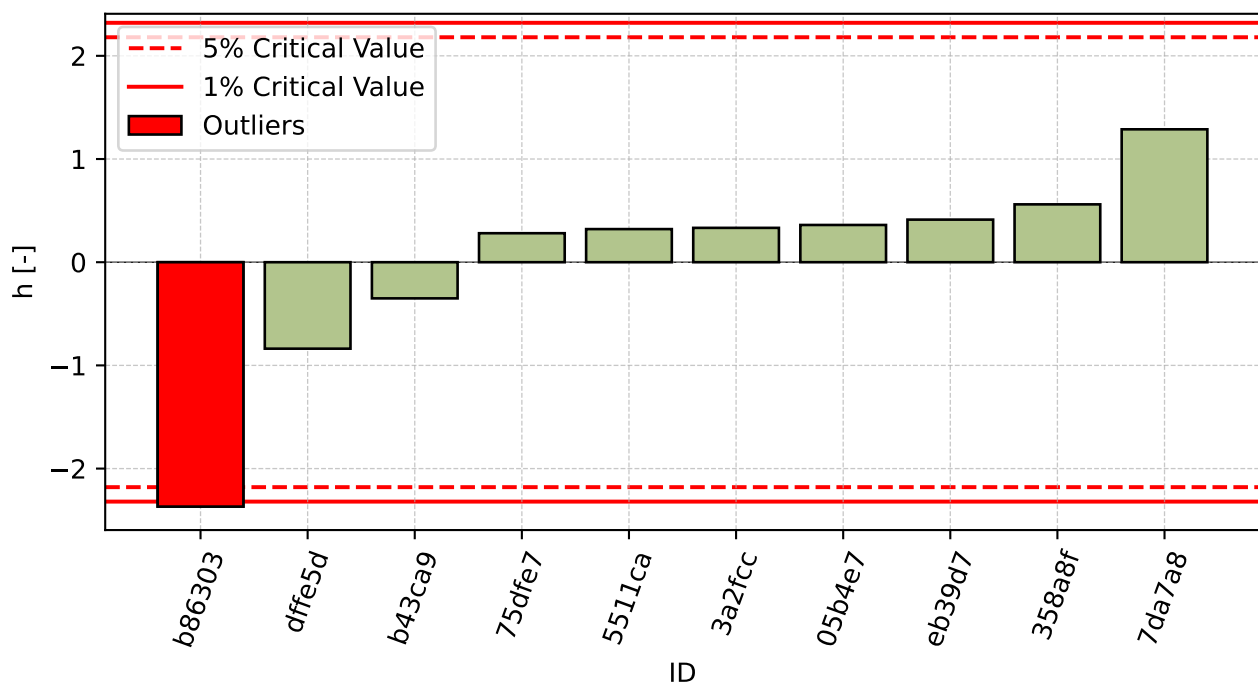


Figure 59: Interlaboratory Consistency Statistic

10.4 Descriptive statistics

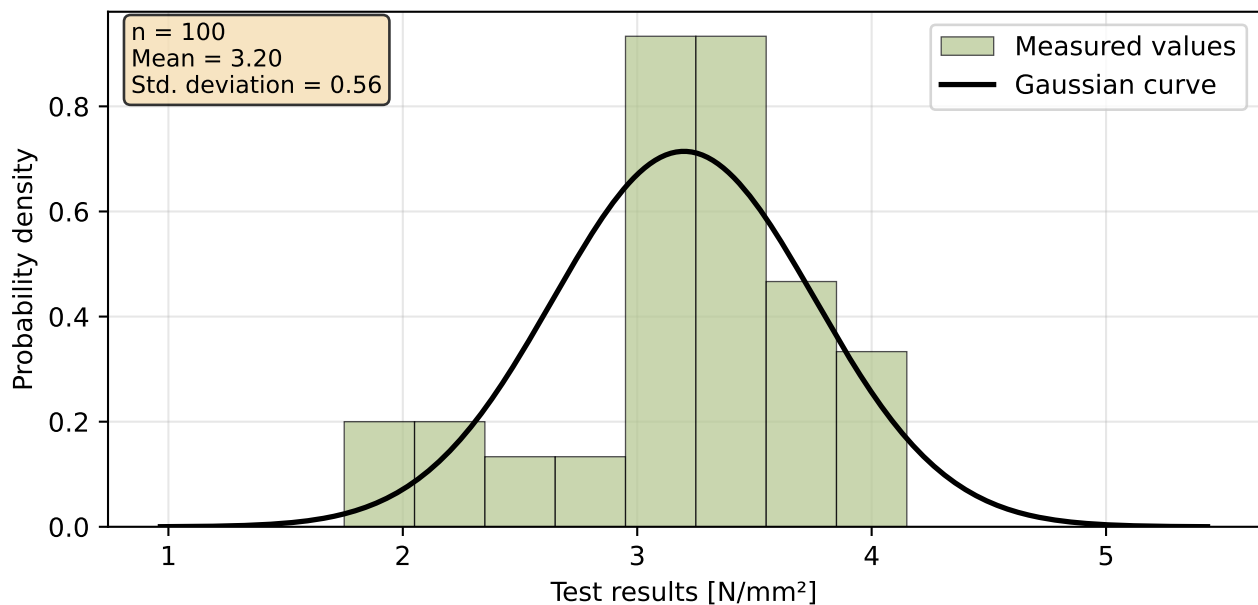


Figure 60: Histogram of all test results

Table 23: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	3.2
Sample standard deviation – s	0.501
Assigned value – x^*	3.2
Robust standard deviation – s^*	0.501
Measurement uncertainty of assigned value – u_X	0.158
p -value of normality test	0.013 [-]
Interlaboratory standard deviation – s_L	0.479
Repeatability standard deviation – s_r	0.323
Reproducibility standard deviation – s_R	0.578
Repeatability – r	0.9
Reproducibility – R	1.62

10.5 Evaluation of Performance Statistics

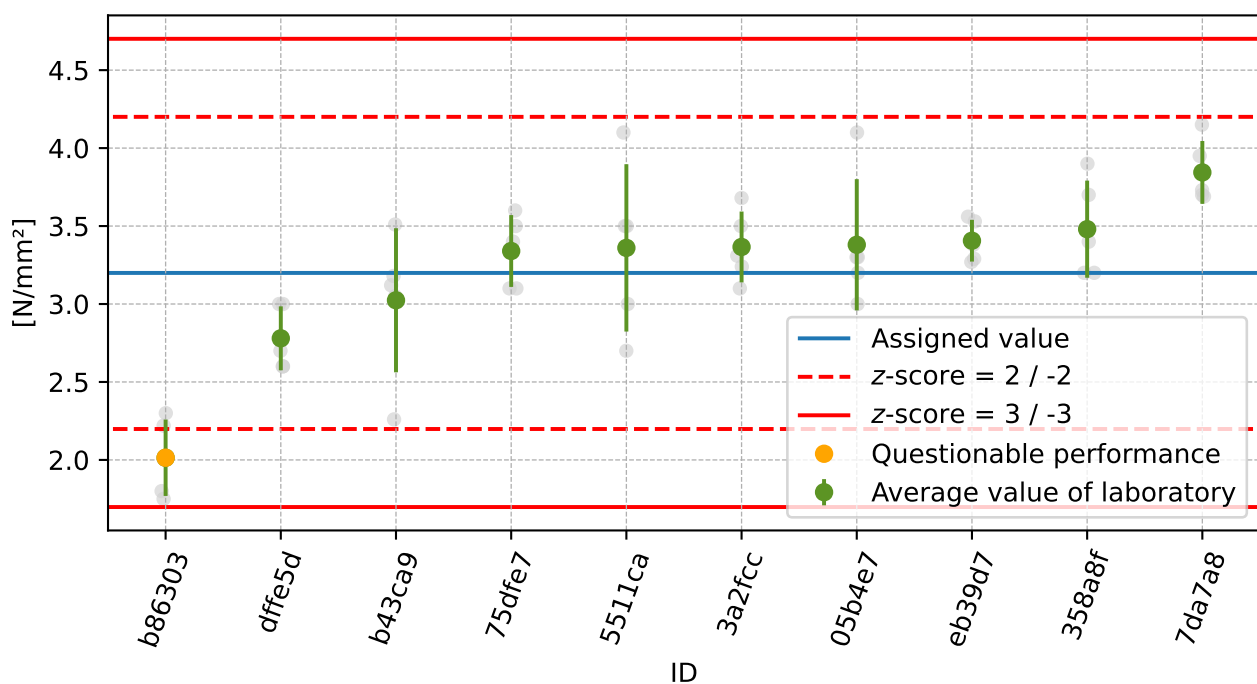


Figure 61: Average values and sample standard deviations

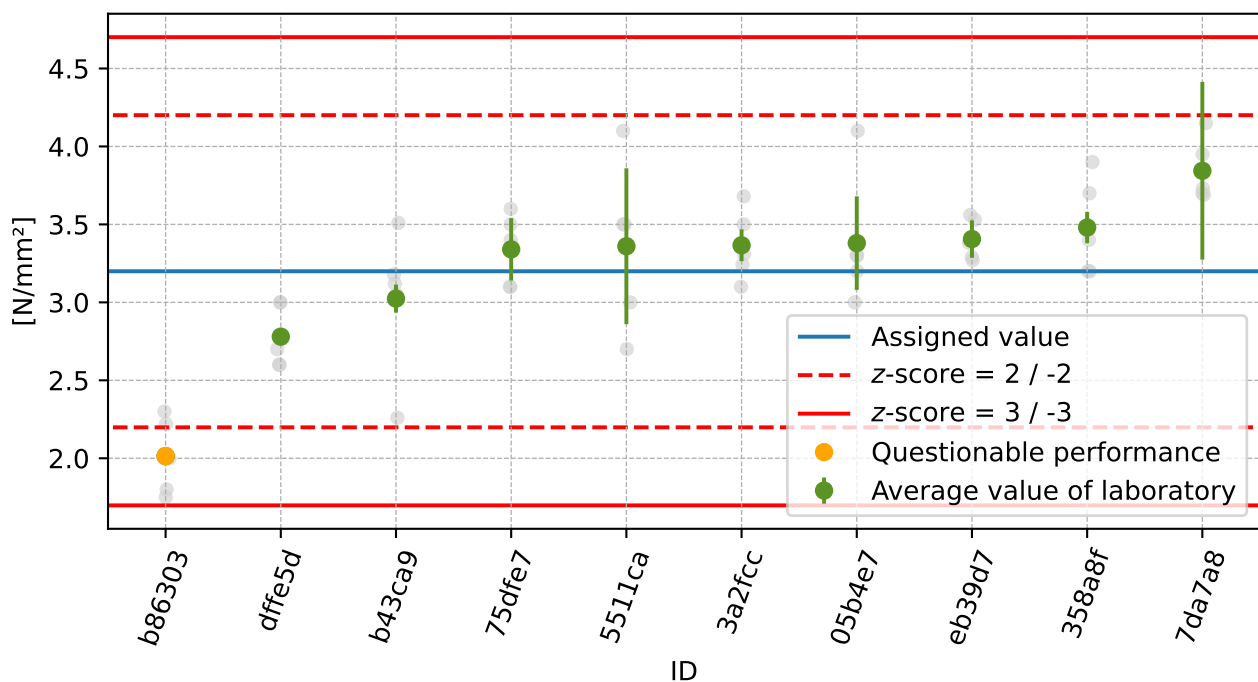


Figure 62: Average values and extended uncertainties of measurement

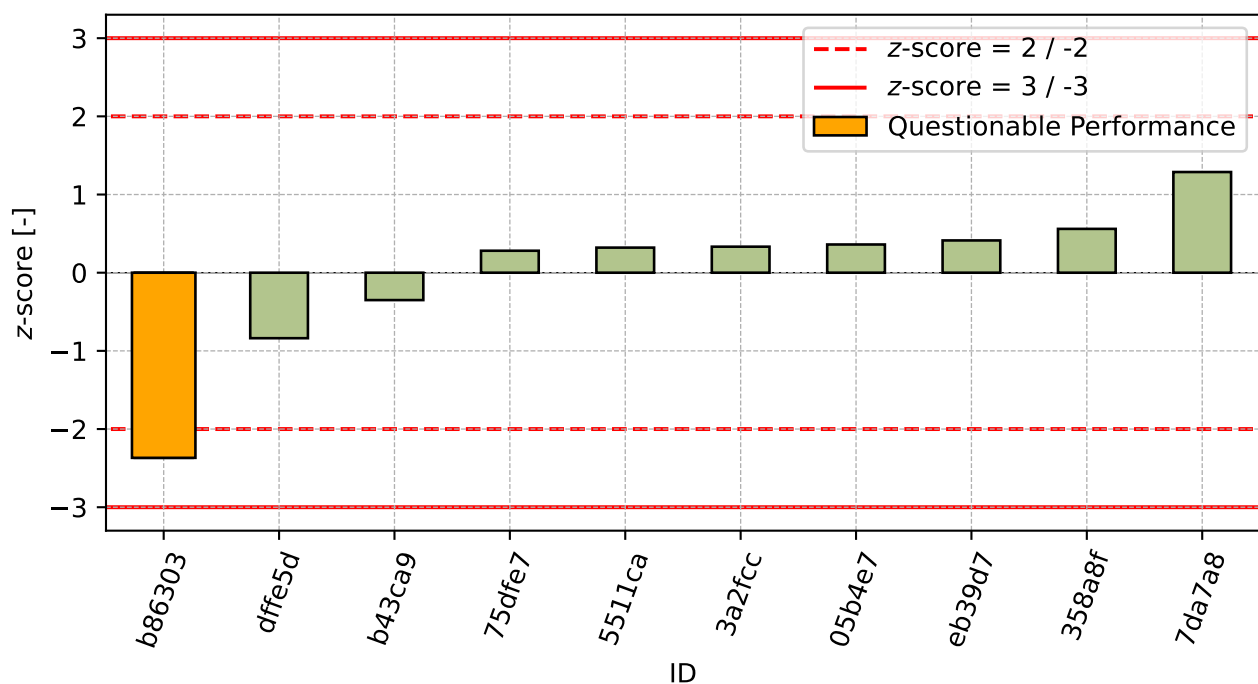
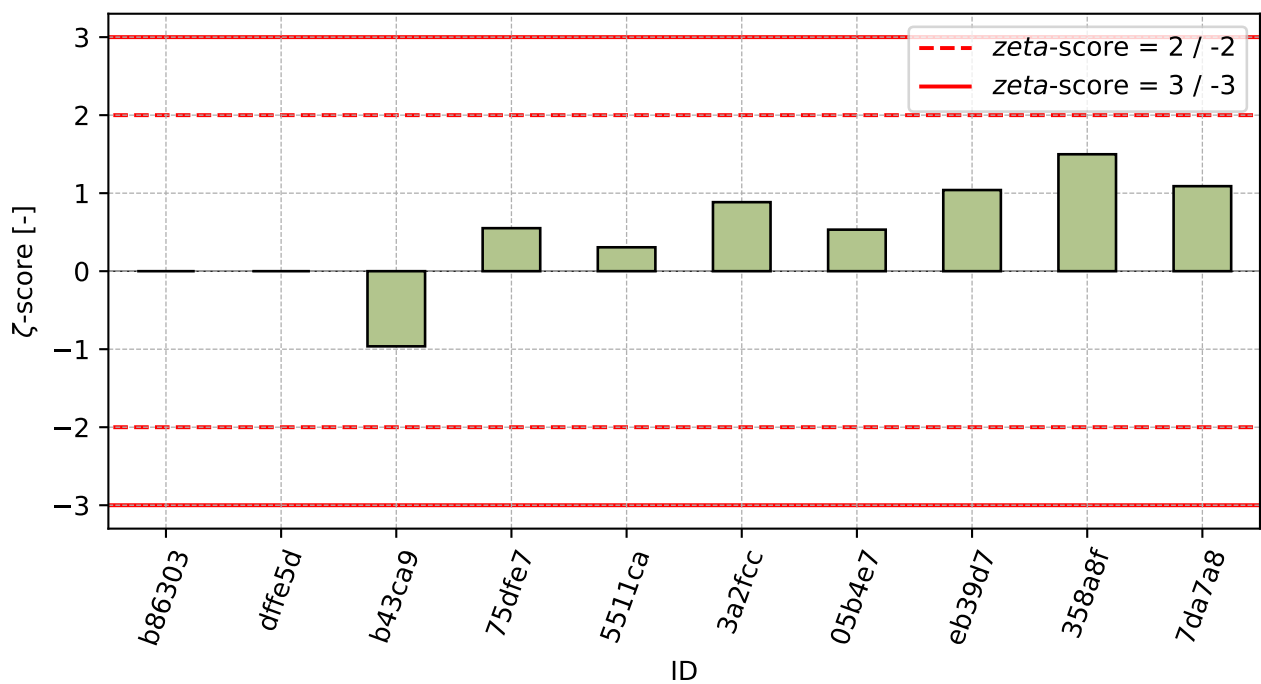


Figure 63: z-score

Figure 64: ζ -scoreTable 24: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
b86303	-2.37	-
dffe5d	-0.84	-
b43ca9	-0.35	-0.96
75dfe7	0.28	0.55
5511ca	0.32	0.31
3a2fcc	0.33	0.88
05b4e7	0.36	0.53
eb39d7	0.41	1.04
358a8f	0.56	1.5
7da7a8	1.29	1.09

11 Appendix – EN 1338 – Appendix E (Total water absorption)

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 [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
106898	3.5	3.5	3.7	0.30	3.6	0.12	3.24
037dc0	3.5	3.6	3.8	0.20	3.6	0.15	4.20
bd4a89	3.6	3.6	3.7	0.50	3.6	0.06	1.59
5511ca	4.0	4.0	3.5	5.00	3.8	0.29	7.53
4cea7c	4.1	3.8	3.7	0.50	3.9	0.21	5.38
05b4e7	4.0	3.9	3.7	0.20	3.9	0.15	3.95

11.2 The Numerical Procedure for Determining Outliers

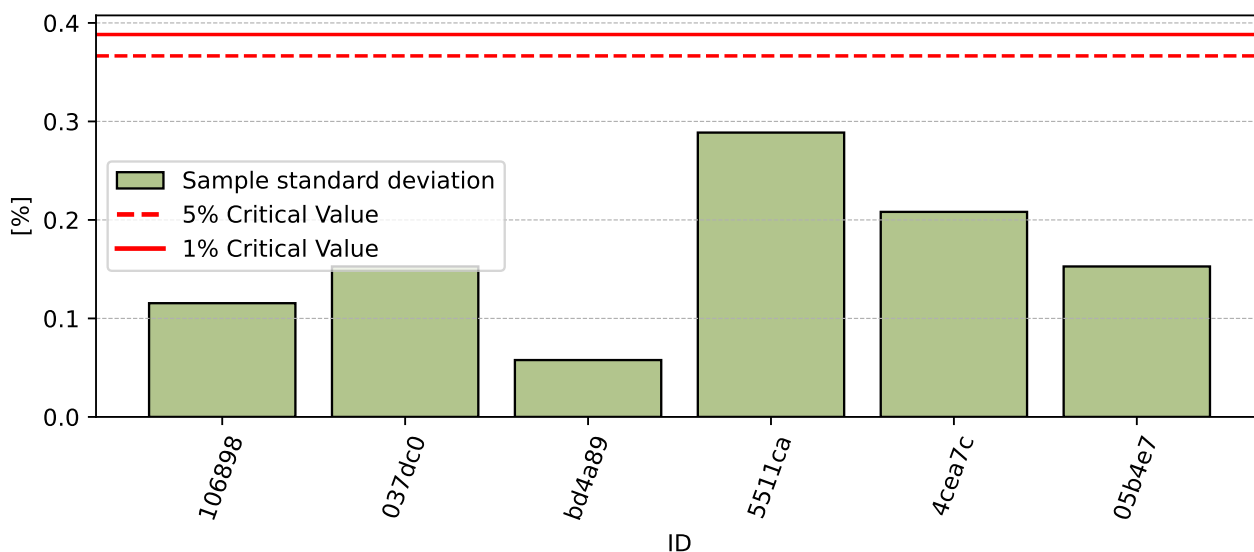
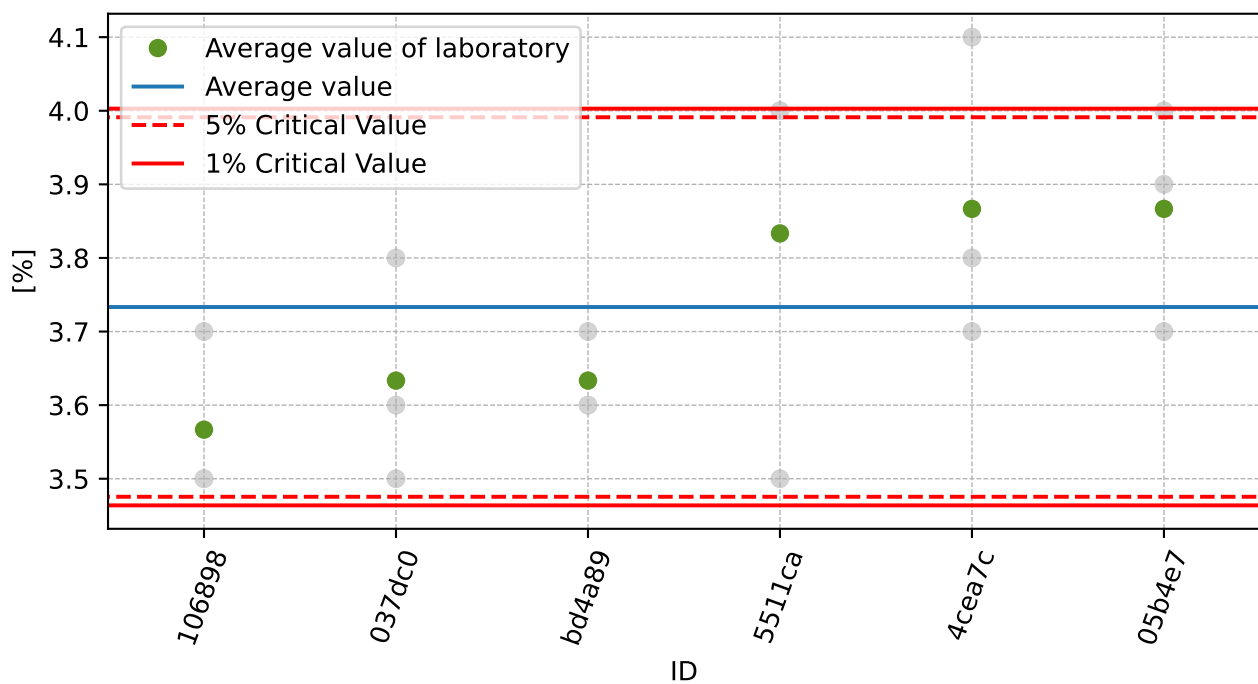


Figure 65: **Cochran's test** - sample standard deviations

Figure 66: **Grubbs' test** - average values

11.3 Mandel's Statistics

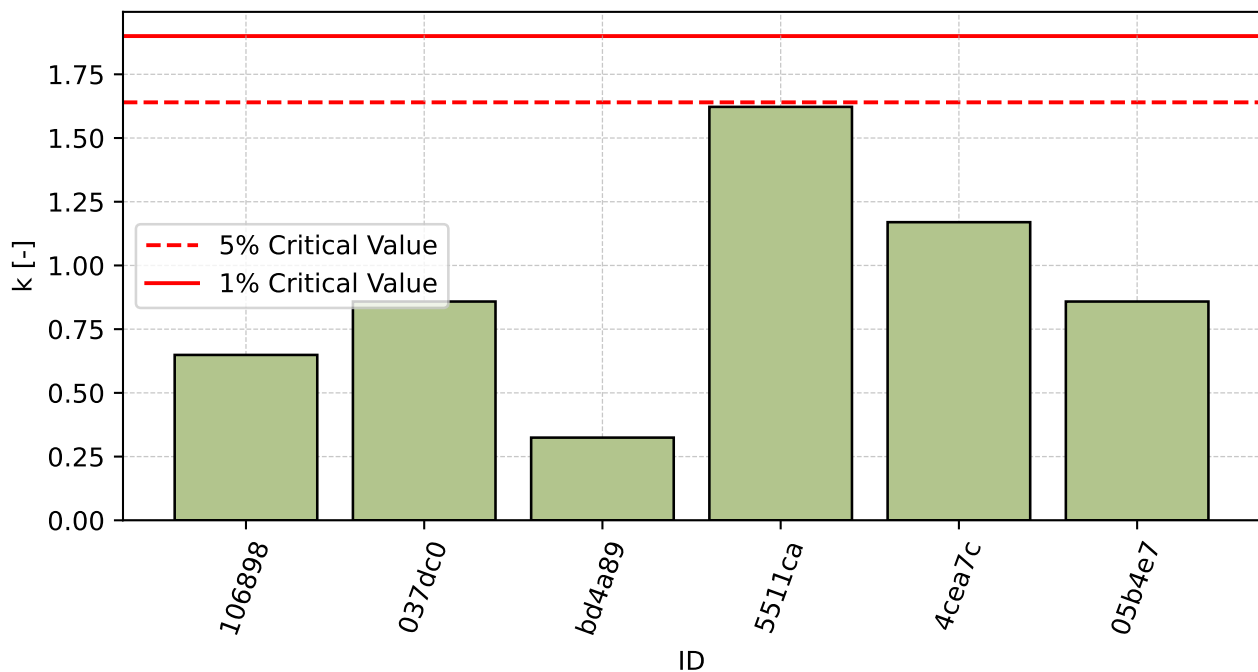


Figure 67: Intralaboratory Consistency Statistic

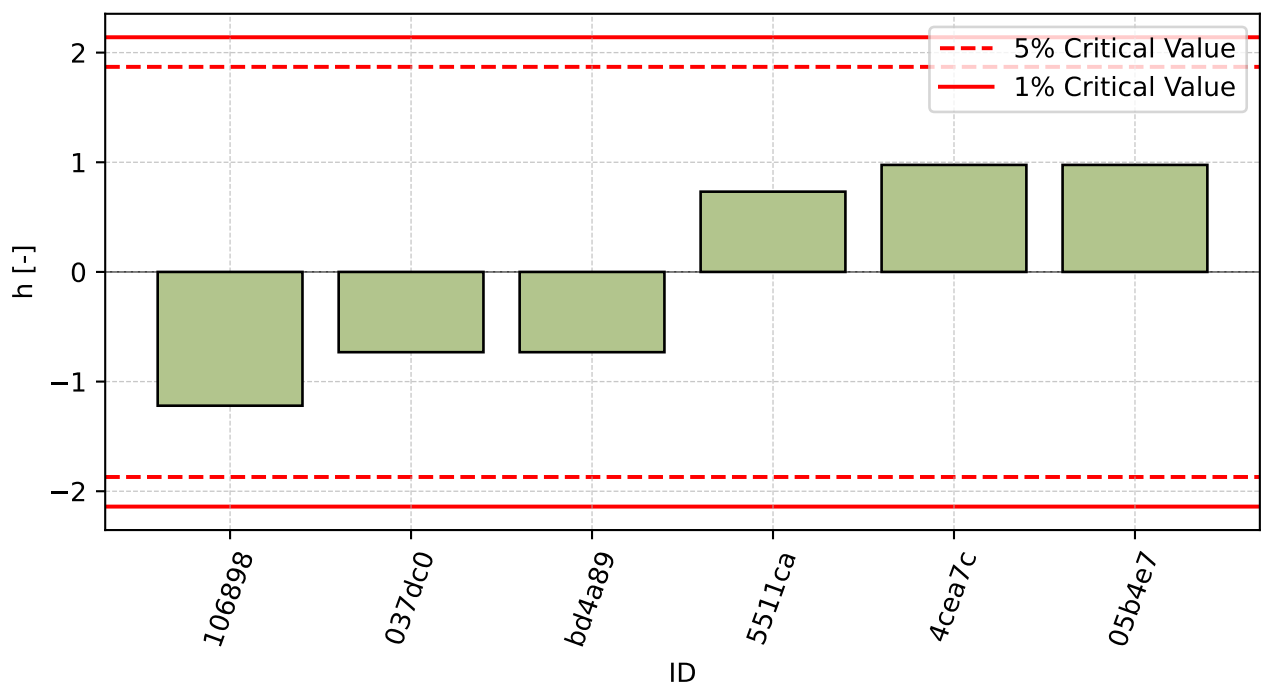


Figure 68: Interlaboratory Consistency Statistic

11.4 Descriptive statistics

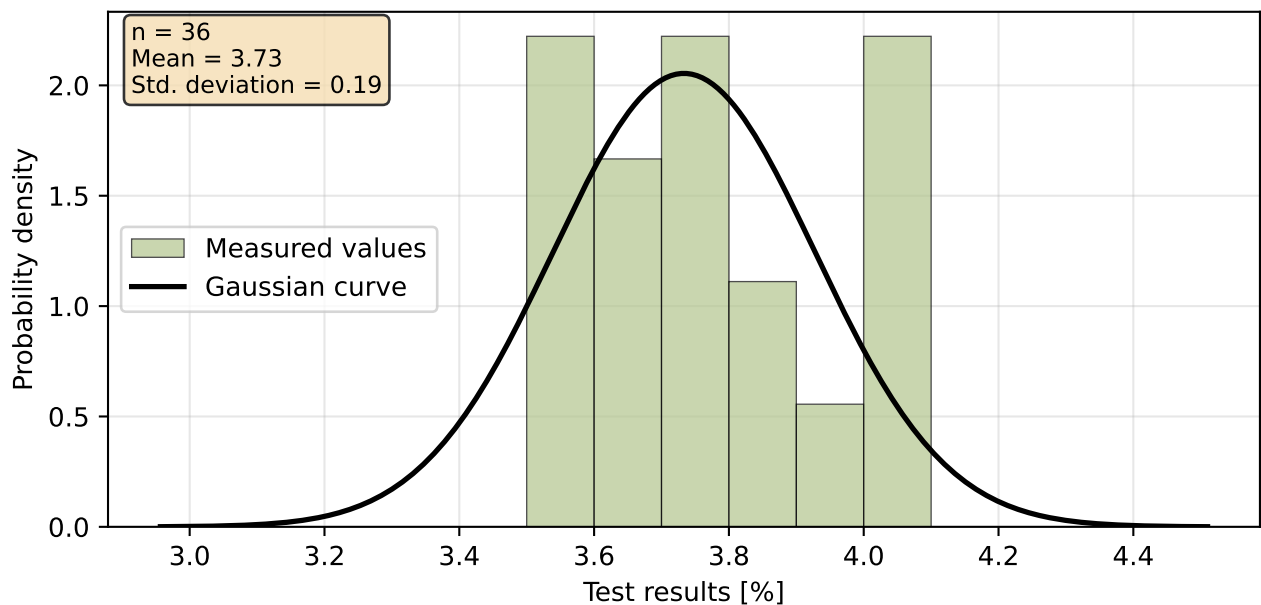


Figure 69: Histogram of all test results

Table 26: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	3.7
Sample standard deviation – s	0.14
Assigned value – x^*	3.7
Robust standard deviation – s^*	0.14
Measurement uncertainty of assigned value – u_X	0.06
p -value of normality test	0.071 [-]
Interlaboratory standard deviation – s_L	0.09
Repeatability standard deviation – s_r	0.18
Reproducibility standard deviation – s_R	0.2
Repeatability – r	0.5
Reproducibility – R	0.6

11.5 Evaluation of Performance Statistics

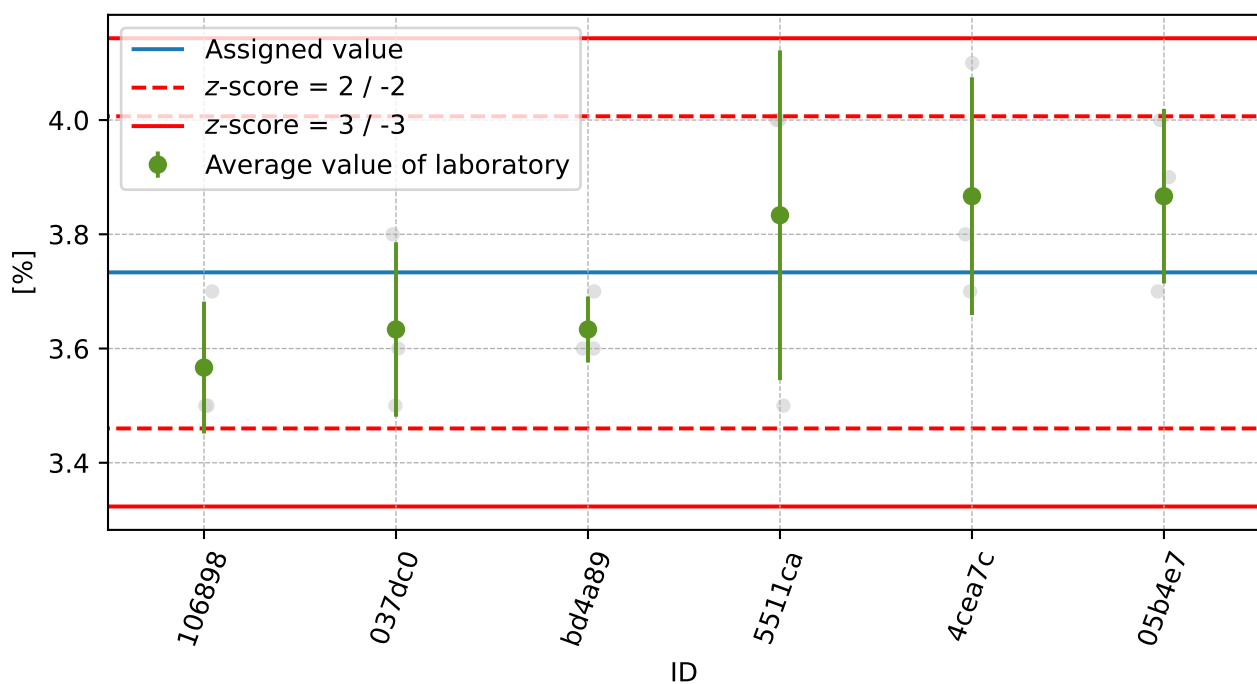


Figure 70: Average values and sample standard deviations

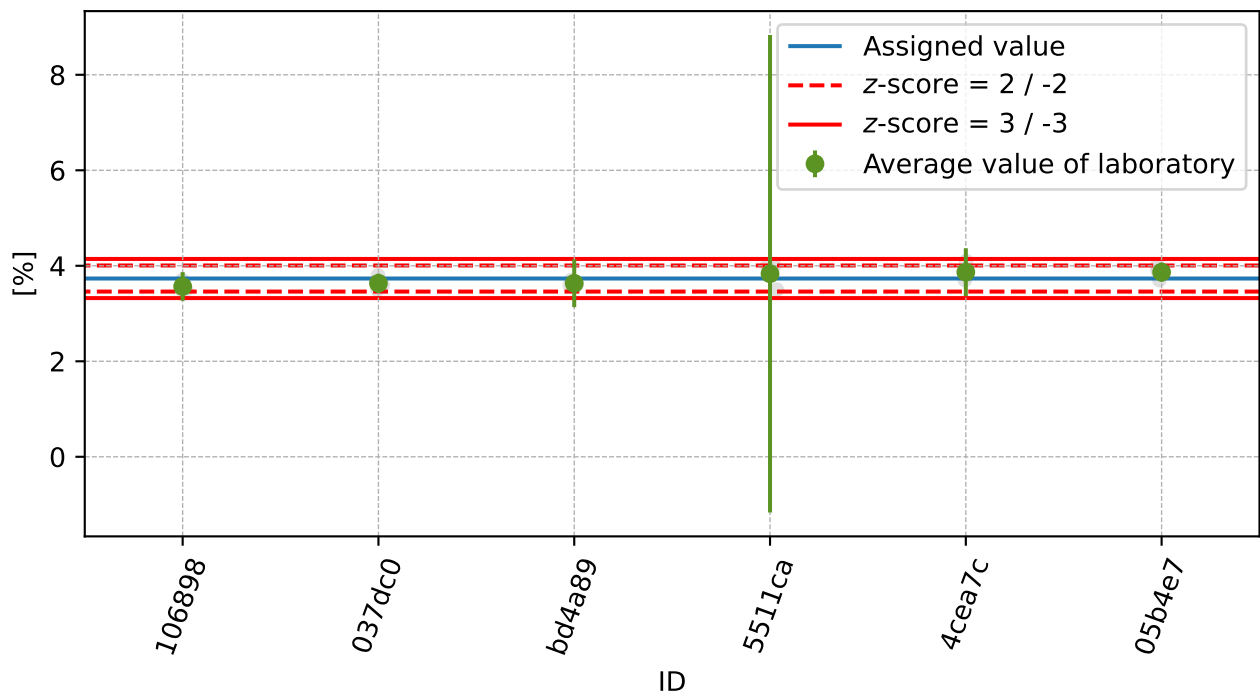


Figure 71: Average values and extended uncertainties of measurement

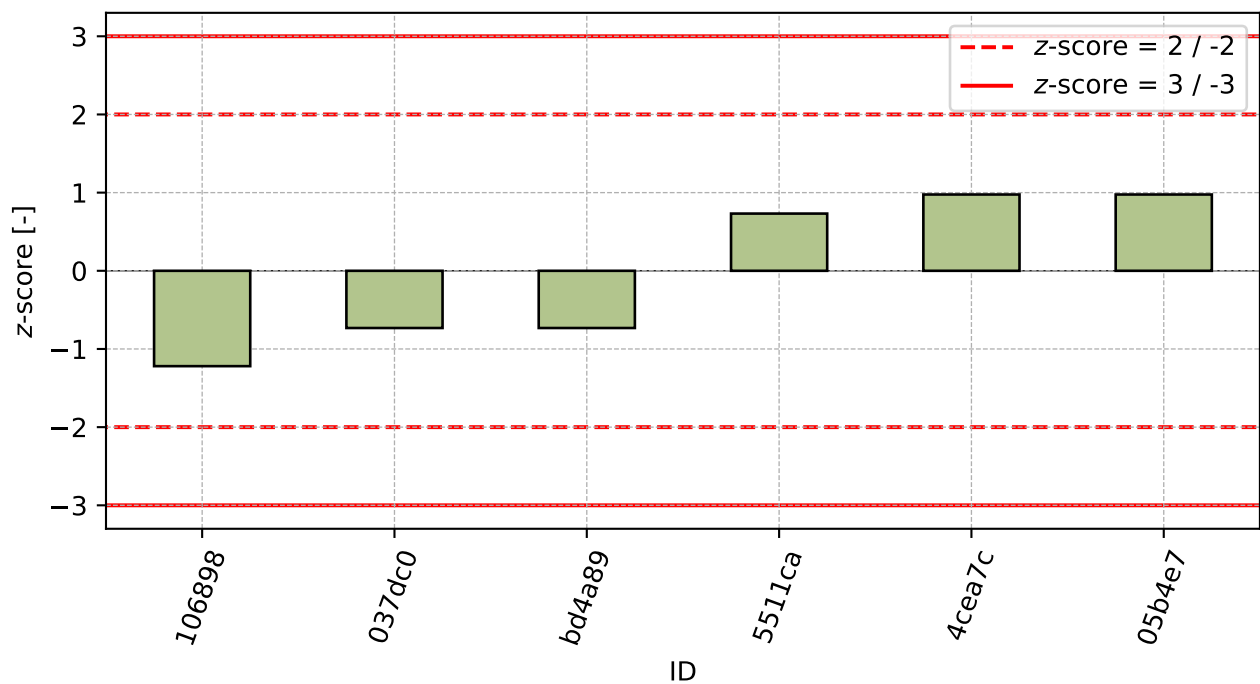


Figure 72: z-score

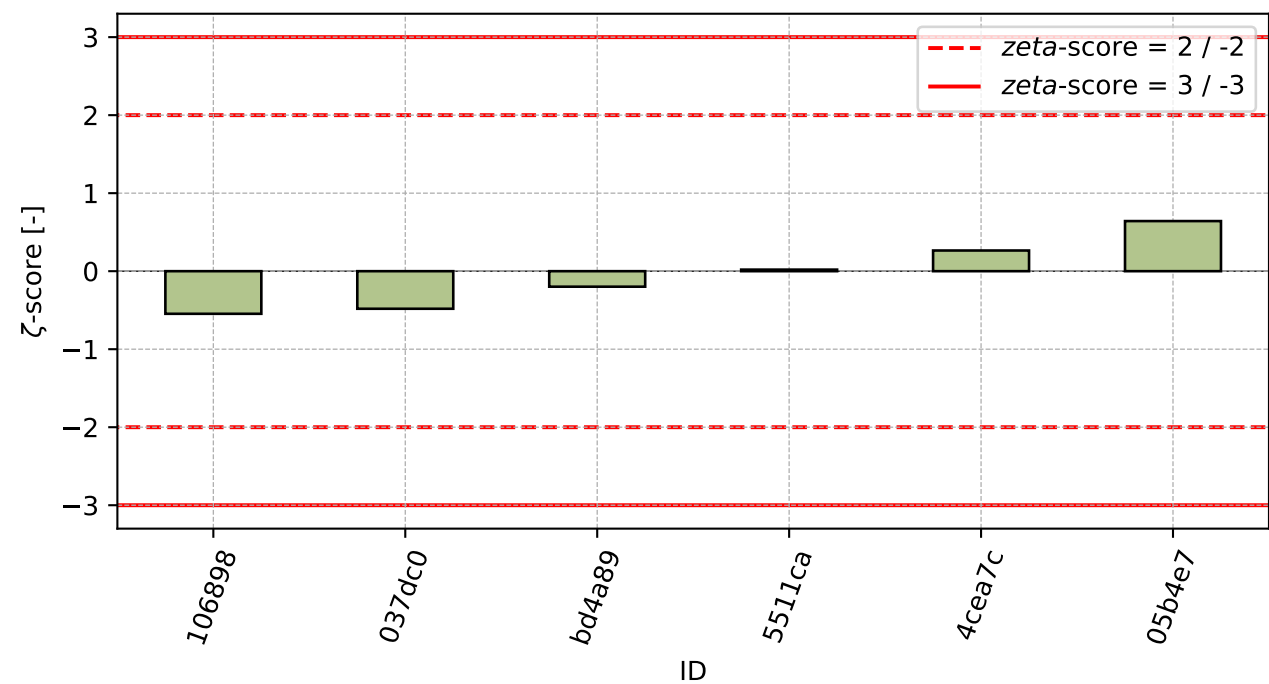


Figure 73: ζ -score

Table 27: z-score and ζ -score

ID	z-score [-]	ζ -score [-]
106898	-1.22	-0.55
037dc0	-0.73	-0.48
bd4a89	-0.73	-0.2
5511ca	0.73	0.02
4cea7c	0.98	0.27
05b4e7	0.98	0.64

12 Appendix – EN 1338 – Appendix F (Tensile splitting strength)

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

13 Appendix – EN 1338 – Appendix G (Abrasion resistance)

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

14 Appendix – EN 1339 – Appendix F (Flexural strength and flexural load)

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