FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

Proficiency Testing Program
Strenght and Elasticity of Hardened Concrete
ZZB 2022/2

Brno University of Technology
Proficiency testing provider at the SZK FAST
Veveří 95, Brno 602 00
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Poskytovatel zkoušení
způsobilosti při SZK FAST

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Z 7008

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Head of the PT Provider, PTP coordinator

Ing. Petr Misák, Ph.D.
Coordinator of PTP results assessment

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1   Introduction and Important Contacts

In the year 2022, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZZB 2022/2 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:

Head of the PT Provider, PTP coordinator

Assoc. Prof. Ing. Tomáš Vymazal, Ph.D.
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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 1338** – Concrete paving blocks - Requirements and test methods – Appendix F (Flexural strength and flexural load) [13].

Testing procedures No 6 and 7 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 [14]. 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

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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.

37 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
2a51a2	-	-	X	-	-	-	-	-	-	-	-	-	-	-
1cafd7	X	-	-	X	-	-	-	-	-	-	-	-	-	-
ea9180	-	-	X	-	-	-	-	-	-	-	-	-	-	-
8b185f	-	X	-	-	-	-	-	-	-	-	-	-	-	-
996aad	X	-	-	X	-	-	-	-	-	-	-	-	-	-
fb0fad	-	-	-	-	-	-	-	-	-	X	-	-	-	-
579364	X	-	-	-	-	-	-	-	-	-	-	-	-	-
40ffae	X	-	-	-	-	-	-	-	-	-	-	-	-	-
60ab49	X	-	-	X	-	-	-	-	X	X	-	-	-	-
e1b3b1	X	-	-	-	-	-	-	-	-	-	-	-	-	-
5828b0	-	X	X	-	-	-	-	-	-	X	X	-	-	-
39f7d6	X	X	X	X	-	-	-	-	-	-	-	-	-	-
75b47e	X	X	-	X	-	-	-	-	-	-	X	-	-	-
9b830f	X	-	-	X	-	-	-	-	-	-	-	-	-	-
75333c	-	-	-	-	-	-	-	-	-	X	-	-	-	-
bfaa5d	X	X	X	X	-	-	-	-	X	X	-	-	-	-
db9775	-	X	X	-	-	-	-	-	X	X	X	X	-	-
8787bd	X	-	-	X	-	-	-	-	-	X	-	-	-	-
d35cb7	X	-	-	-	-	-	-	-	-	-	-	-	-	-
dac671	X	-	-	X	-	-	-	-	-	-	-	-	-	-
08a6a5	X	-	-	X	-	-	-	-	-	-	-	-	-	-
7860ce	-	-	X	-	-	-	-	-	X	X	-	-	-	-
a48362	X	-	-	X	-	-	-	-	-	-	-	-	-	-
3745af	-	-	-	-	-	-	-	-	-	X	-	-	-	-
a6484c	X	X	X	X	-	-	-	-	-	-	-	-	-	-
8b2e1e	X	-	-	-	-	-	-	-	X	-	-	-	-	-
35991b	X	X	X	X	-	-	-	-	-	-	-	-	-	-
4b9a6e	-	-	-	-	-	-	-	-	-	-	X	X	-	-
d00715	-	-	-	-	-	-	-	-	-	X	-	-	-	-
45bcf6	X	-	-	-	-	-	-	-	-	-	-	-	-	-
d0f586	-	-	-	-	-	-	-	-	-	-	-	X	-	-
33dab4	X	-	-	X	-	-	-	-	-	X	-	-	-	-
8dd9e4	X	-	-	X	-	-	-	-	-	X	X	-	-	-
dbf94c	X	X	X	X	-	-	-	-	X	X	-	-	-	-
0a458f	X	-	-	X	-	-	-	-	-	X	X	X	-	-
96c8ad	X	-	-	X	-	-	-	-	-	X	-	X	-	-

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ID/Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14
a21c3b	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
Bechtel ENKA UK Limited Ogranak Beograd	Jasicki put 52 dj, Krusevac, 37000, Serbia	nan
BetónRacio, s.r.o., Skúšobné laboratórium, Pracovisko Lietavská Lúčka	Skladová 2, Trnava, 917 00, Slovenská republika	S-320
BetónRacio, s.r.o., Skúšobné laboratórium, Pracovisko Trnava	Skladová 2, Trnava, 917 00, Slovenská republika	S-320
BetónRacio, s.r.o., Skúšobné laboratórium, Pracovisko Veľký Šariš	Skladová 2, Trnava, 917 00, Slovenskárepublika	S-320
CMR CENTER MATERIALS RESEARCH SNC	VIA ZAMENHOF 589, VICENZA, 36100, Italia	nan
Cemex CR s.r.o.	Semtín 102, Pardubice, 53354, Česká republika	1302
Debbie van den Hemel	Industriepark Oost 6, Beernem, 8730, West - Vlaanderen	BELAC 637-TEST
GIM-TEST D.O.O. BANJA LUKA	Palih boraca 55, local No. 2, Banja Luka, 78000, RS, BiH	LI-152-01
Graz University of Technology	Rechbauerstraße 12, Graz, 8010, Austria	nan
Grean Consult BV	Acaciastraat 14C - Gate 1, Geel, 2440, Belgium	nan
Horský s.r.o.	Klánovická 286, Praha, 198 00, ČR	1207
INSTITUT IGH d.d. Laboratorij za materijale i konstrukcije - RC Split (lokacija Dubrovnik)	Vukovarska 8, Dubrovnik, 20000, Croatia (Hrvatska)	1043
INSTITUT IGH, d.d. za istraživanje i razvoj u graditeljstvu	Janka Rakuše 1, Zagreb, 10000, Croatia	1043
Institut IGH, d.d., Laboratorij za materijale i konstrukcije - RC Split	Matice hrvatske 15, Split, 21000, Croatia	1043
Institut technologie a testování betonu, s.r.o., Zkušební laboratoř ITTB Brno, č. 1778	Medkova 4, Brno - Tuřany, 62700, Česká republika	1778
JKV TEST s.r.o.	Suhrady 148/4, Vřesina, 747 20, Česká republika	1294
M.I.S. a.s.	Resslova 956/13, Hradec Králové, 500 02, Česká republika	1197
MIRTEC S.A.	76 km of Athens-Lamia National Road, Ritsona, 32009, Greece	nan

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Laboratory	Address	Accreditation number
Magnel-Vandepitte Laboratory	Technologiepark-Zwijnaarde 60, Zwijnaarde (Ghent), 9052, Belgium	220-TEST
Národná diaľničná spoločnosť a.s.	Dúbravská cesta 14, Bratislava, 841 04, Slovenská republika	456/S-328
Radis d.o.o PJ Radis Institut	Jovana Ducica 16, Istocno Sarajevo, 71123, Bosna i Hercegovina	nan
SQZ, s.r.o. - organizačná zložka Bratislava, Pracovisko Bratislava	Mlynské Nivy 68, Bratislava, 82105, Slovensko	566/S-376
SQZ, s.r.o., Ústřední laboratoř Praha -pracoviště Zbraslav	U Místní Dráhy 939/5, Olomouc, 77900, Česká republika	1135.2
Slovenská správa ciest, IVSC Žilina, Oblastné laboratórium	Martina Rázusa, 104/A, Žilina, 01001, Slovenská republika	181/S-322
Stavební fakulta ČVUT v Praze	Thakurova 7, Praha, 166 29, Česká republika	1048
TPA EOOD CTC SOFIA, Sofia, 7 Rezbarska str.	Rezbarska № 7, Sofia, 1510, Bulgaria	nan
Technický a zkušební ústav stavební Praha, s.p., zkušebna Praha	Prosecká 76a, Praha 9, 190 00, Česká republika	1018.3
Teknologisk Institut	Kongsvang Allé 29, Aarhus, 8000, Denmark	nan
Universität für Bodenkultur Wien, Department für Bautechnik und Naturgefahren, Institut für Konstruktiven Ingenieurbau	Peter-Jordan-Str. 82, Vienna, 1190, Austria	nan
VANJA LUKIĆ PREDUZETNIK PILON PROJEKT	Bulevar Nikole Tesle 35, Niš, 18000, Serbia	nan
Vysoké učení technické v Brně	Veveří 95, Brno, 60200, Česká republika	Z7008
Vysoké učení technické v Brně, Fakulta stavební, Zkušební laboratoř při ÚTHD FAST VUT v Brně - č. 1396	Veveří 331/95, Brno, 61200, Česká republika	1396
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.	Pf. 180., Szentendre, 2001, Hungary	NAH-1-1110/2018/K
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.	Pf. 180., Szentendre, 2001, Hungary	nan
Ředitelství silnic a dálnic ČR	Rebešovická 40, Brno-Chrlice, 643 00, Česká republika	1072
Ředitelství silnic a dálnic ČR, Laboratoř Praha	Čerčanská 12, Praha 4, 140 00, Česká republika	1734
"ЦЕНТЪР ЗА ИЗПИТВАНЕ И ЕВРОПЕЙСКА СЕРТИФИКАЦИЯ" ЕООД/Center for Testing and European Certification Ltd.	2, Industrialna street, Stara Zagora, 6006, Bulgaria	252 LI

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,

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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.

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3　Conclusions of the Statistical Analysis

The present report summarizes the results of the Proficiency Testing Program Strenght and Elasticity of Hardened Concrete (PT Program) organized by the PT Provider at the SZK FAST. 37 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	6	7	8	9	10	11	12	13	14
2a51a2	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
1cafd7	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
ea9180	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
8b185f	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
996aad	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
fb0fad	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
579364	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
40ffae	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
60ab49	✓	-	-	✓	-	-	-	-	✓	✓	-	-	-	-
e1b3b1	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
5828b0	-	✓	✓	-	-	-	-	-	-	✓	✓	-	-	-
39f7d6	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	-
75b47e	✓	✓	-	✓	-	-	-	-	-	-	✓	-	-	-
9b830f	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
75333c	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
bfaa5d	✓	✓	✓	✓	-	-	-	-	✓	**!**	-	-	-	-
db9775	-	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-	-
8787bd	✓	-	-	✓	-	-	-	-	-	✓	-	-	-	-
d35cb7	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
dac671	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
08a6a5	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
7860ce	-	-	✓	-	-	-	-	-	✓	✓	-	-	-	-
a48362	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
3745af	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
a6484c	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	-
8b2e1e	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-
35991b	**X**	✓	✓	✓	-	-	-	-	-	-	-	-	-	-
4b9a6e	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-

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ID / Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14
d00715	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
45bcf6	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
d0f586	-	-	-	-	-	-	-	-	-	-	-	✓	-	-
33dab4	✓	-	-	✓	-	-	-	-	-	✓	-	-	-	-
8dd9e4	✓	-	-	✓	-	-	-	-	-	?	✓	-	-	-
dbf94c	✓	✓	✓	✓	-	-	-	-	✓	✓	-	-	-	-
0a458f	✓	-	-	✓	-	-	-	-	-	✓	✓	✓	-	-
96c8ad	?	-	-	✓	-	-	-	-	-	✓	-	✓	-	-
a21c3b	?	-	-	✓	-	-	-	-	-	-	-	✓	-	-

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References

[1]   EN 12390-3. *Testing hardened concrete - Part 3: Compressive strength of test specimens*. 2020.

[2]   EN 12390-5. *Testing hardened concrete - Part 5: Flexural strength of test specimens*. 2020.

[3]   EN 12390-6. *Testing hardened concrete - Part 6: Tensile splitting strength of test specimens*. 2010.

[4]   EN 12390-7. *Testing hardened concrete - Part 7: Density of hardened concrete*. 2020.

[5]   ISO 1920-10. *Testing of concrete - Part 10: Determination of static modulus of elasticity in compression*. 2016.

[6]   EN 12390-13. *Testing hardened concrete - Part 13: Determination of secant modulus of elasticity in compression*. 2014.

[7]   EN 12504-4. *Testing concrete - Part 4: Determination of ultrasonic pulse velocity*. 2005.

[8]   ČSN 731371. *Non-destructive testing of concrete - Method of ultrasonic pulse testing of concrete*. 2011.

[9]   ČSN 731373. *Non-destructive testing of concrete - Determination of compressive strength by hardness testing methods*. 2011.

[10] EN 12504-2. *Testing concrete in structures - Part 2: Non-destructive testing - Determination of rebound number*. 2013.

[11] EN 1542. *Products and systems for the protection and repair of concrete structures - Test methods - Measurement of bond strength by pull-off*. 2000.

[12] ČSN 736242. *Design and construction of pavements on road bridges*. 2010.

[13] EN 1338. *Concrete paving blocks - Requirements and test methods*. 2004.

[14] EN 206:2013+A2:2021. *Concrete - Specification, performance, production and conformity*. 2021.

[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*. 1997.

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

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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 [%]
579364	35.2	40.8	43.8	1.4	39.9	4.37	10.93
dac671	41.4	42.0	39.6	2.3	41.0	1.25	3.05
bfaa5d	40.6	41.4	42.3	2.4	41.4	0.85	2.05
08a6a5	41.3	41.0	42.2	-	41.5	0.62	1.5
e1b3b1	42.5	42.4	39.9	0.4	41.6	1.47	3.54
a6484c	41.2	40.7	42.9	1.8	41.6	1.18	2.83
1cafd7	41.0	43.0	41.6	-	41.9	1.02	2.43
75b47e	42.0	42.0	41.6	-	41.9	0.23	0.55
60ab49	42.1	42.0	42.2	2.2	42.1	0.1	0.24
8787bd	43.8	43.3	39.2	2.7	42.1	2.52	5.99
40ffae	41.8	41.9	42.7	1.0	42.1	0.49	1.17
0a458f	43.1	41.0	42.8	1.0	42.3	1.14	2.69
d35cb7	43.1	42.2	43.2	1.2	42.8	0.55	1.29
996aad	43.4	42.8	42.8	1.3	43.0	0.35	0.81
45bcf6	44.3	43.1	42.0	0.6	43.1	1.15	2.67
8b2e1e	42.7	42.8	44.1	0.0	43.2	0.78	1.81
39f7d6	44.1	42.4	43.7	-	43.4	0.89	2.05
9b830f	43.6	45.4	42.9	-	44.0	1.29	2.93
dbf94c	45.0	44.9	42.3	2.5	44.1	1.53	3.47
33dab4	45.0	42.4	45.1	2.5	44.2	1.53	3.47
8dd9e4	46.1	44.3	44.9	1.0	45.1	0.92	2.03
a21c3b	47.1	47.0	45.8	2.8	46.6	0.72	1.55
a48362	45.9	43.1	53.7	-	47.6	5.49	11.55
96c8ad	46.7	49.4	47.2	4.0	47.8	1.44	3.01
35991b	50.6	50.2	53.1	0.5	51.3	1.57	3.06

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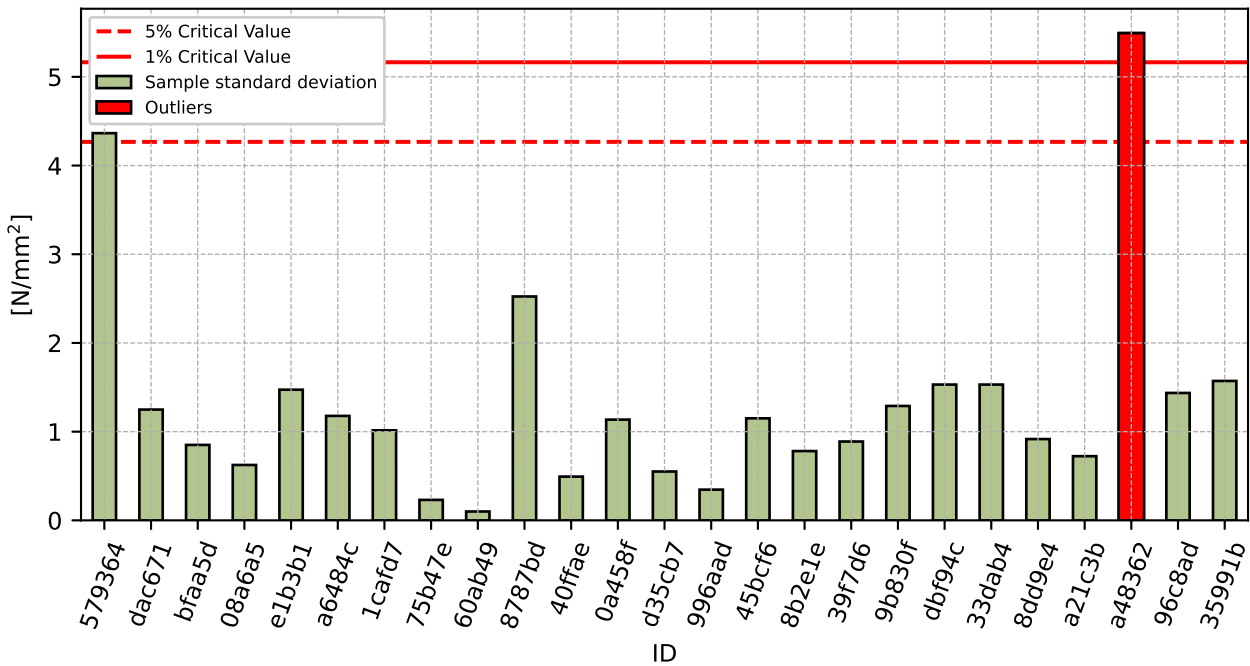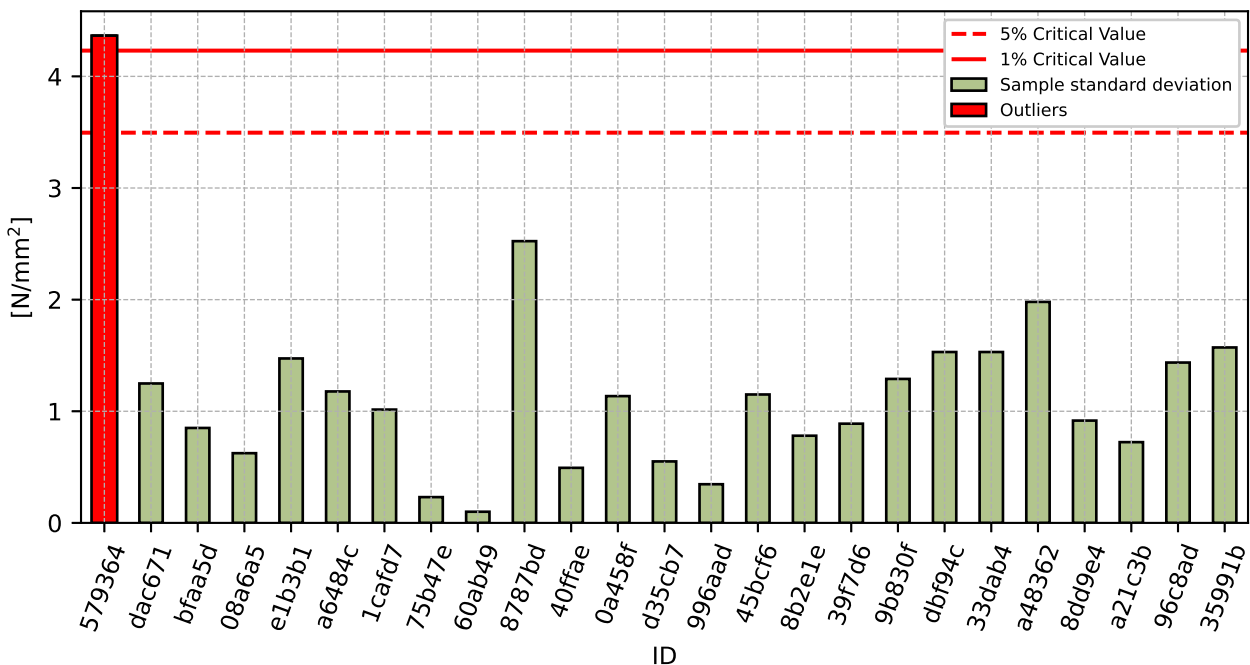
1.2   The Numerical Procedure for Determining Outliers

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

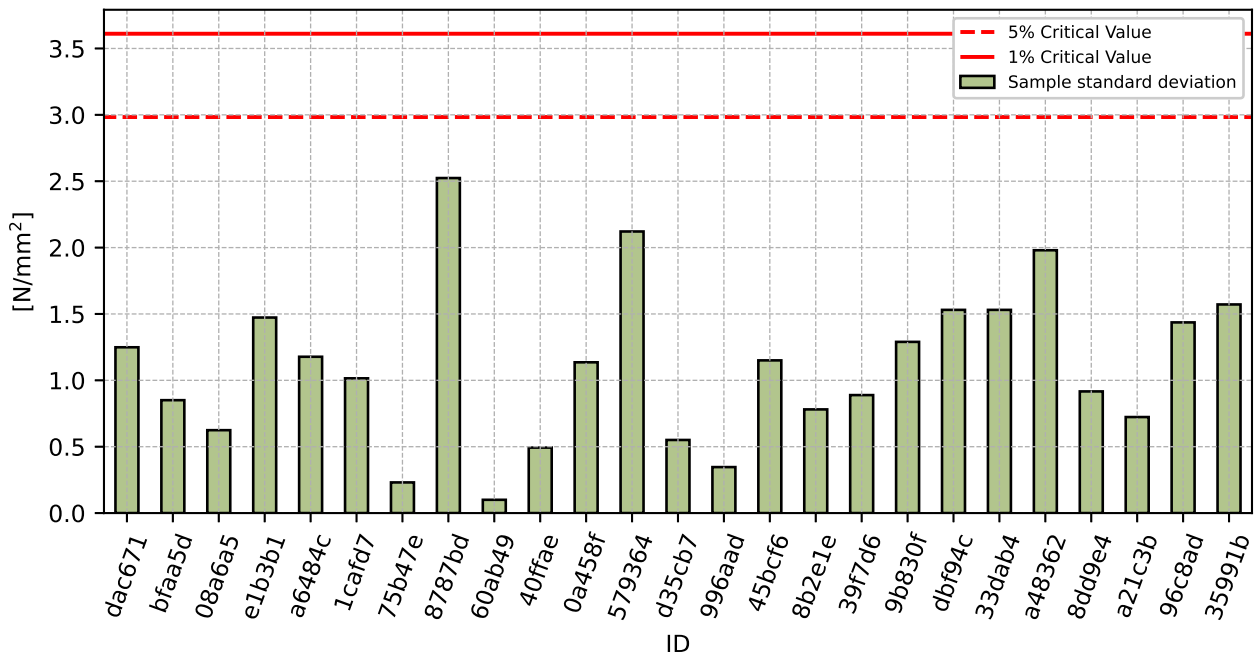Figure 2: **Cochran's test** - sample standard deviations without outliers

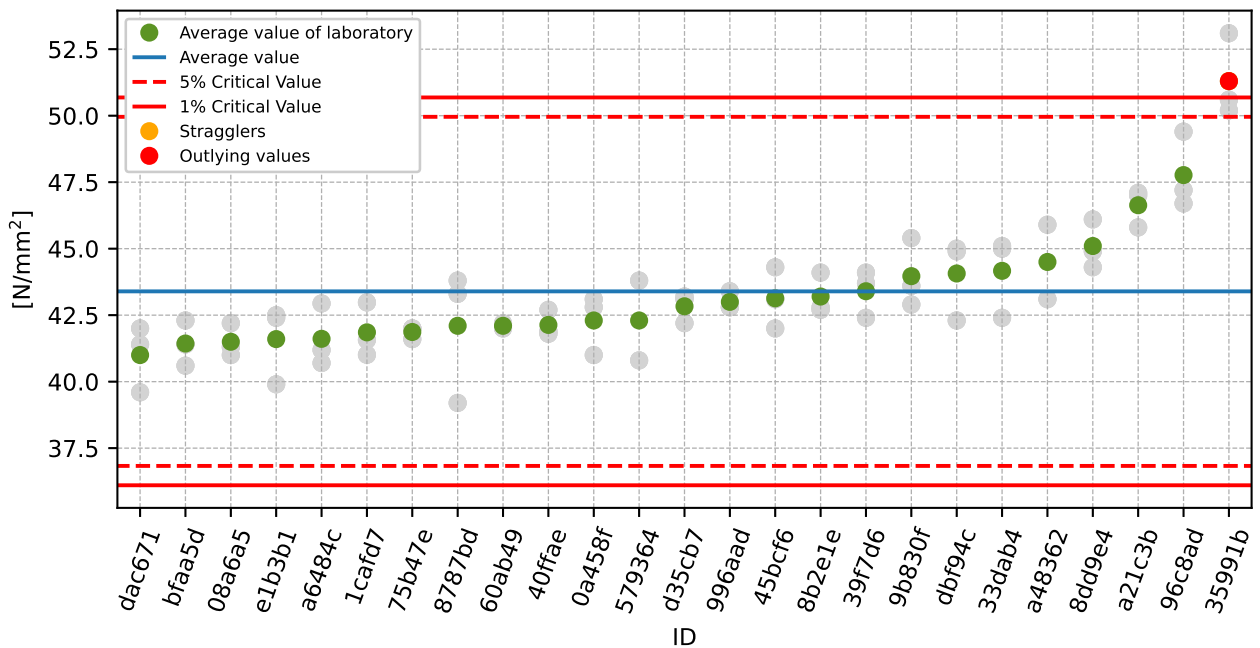Proficiency Testing Provider at the SZK FAST | Z 7008   12/65
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Figure 3: **Cochran's test** - sample standard deviations without outliers

Figure 4: **Grubbs' test** - average values

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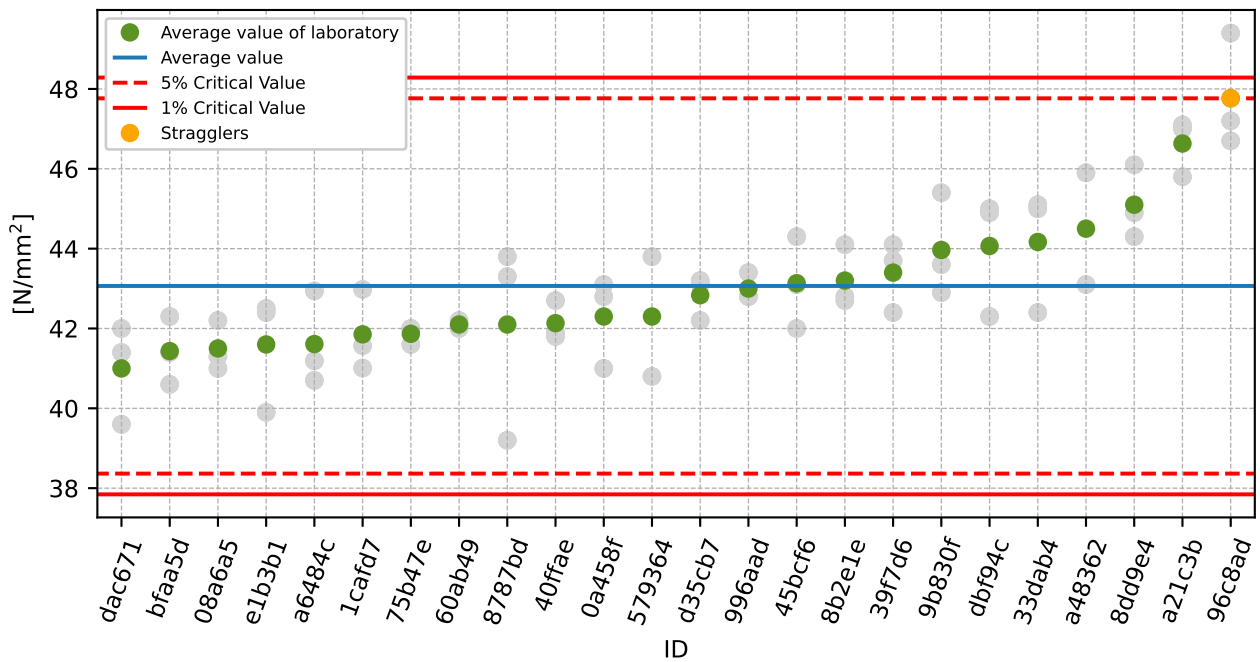Veveří 331/95 | 602 00 Brno | Czech Republic
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Figure 5: **Grubbs' test** - average values without outliers

1.3 Mandel's Statistics
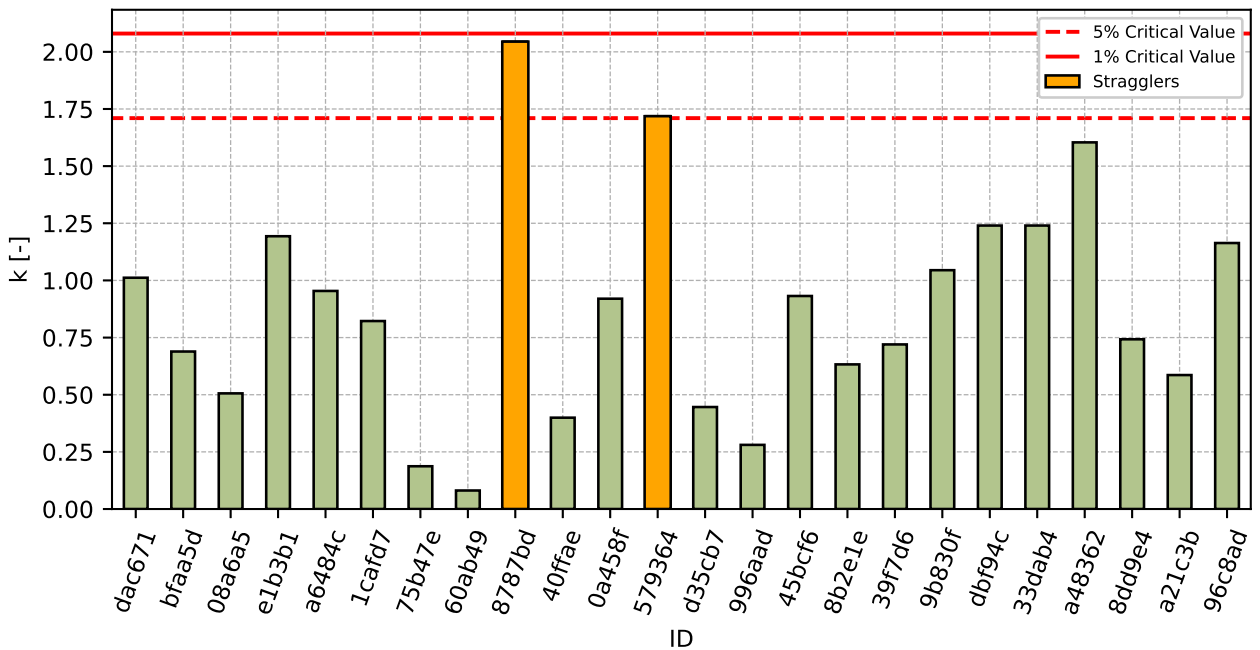
Figure 6: Intralaboratory Consistency Statistic

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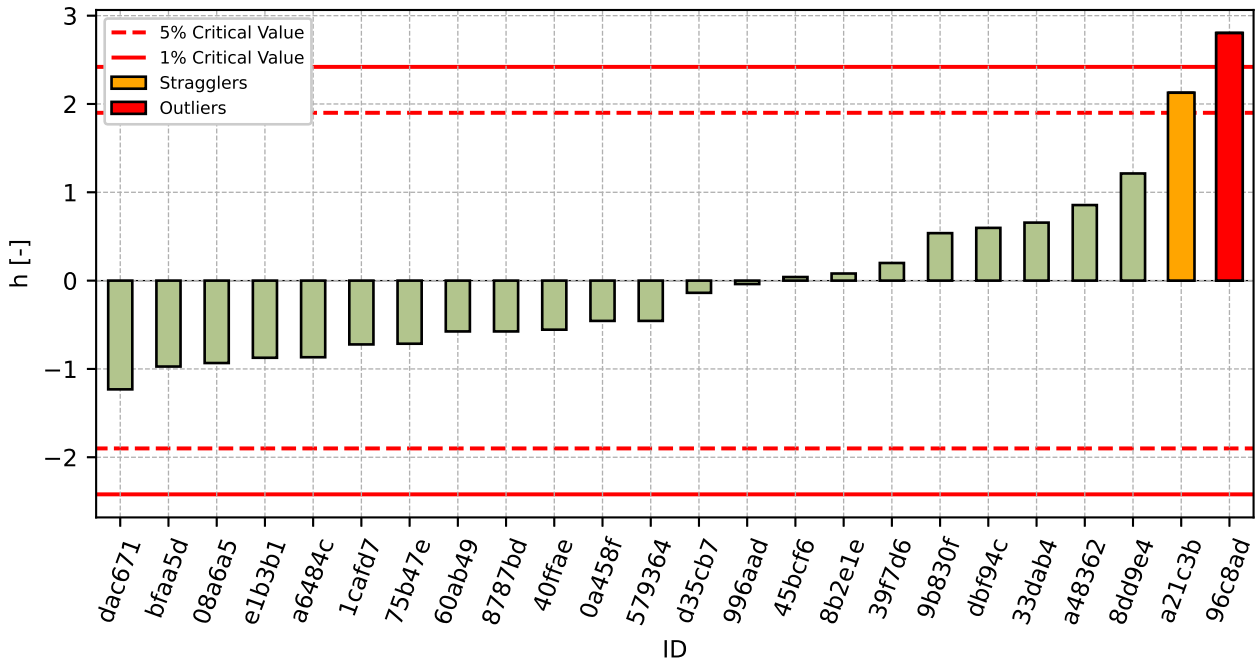
Figure 7: Interlaboratory Consistency Statistic

1.4 Descriptive statistics
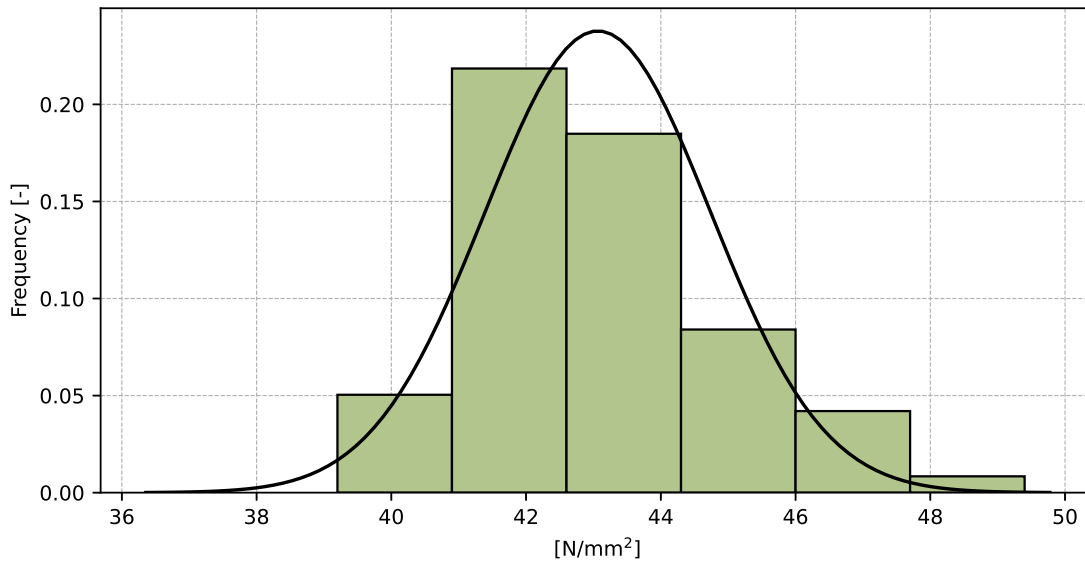
Figure 8: Histogram of all test results

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Table 5: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	43.1
Sample standard deviation – s	1.68
Asigned value – x^*	43.0
Robust standard deviation – s^*	1.67
Measurement uncertainty of asigned value – u_X	0.43
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	1.52
Repeatability standard deviation – s_r	1.23
Reproducibility standard deviation – s_R	1.96
Repeatability – r	3.5
Reproducibility – R	5.5

1.5　Evaluation of Performance Statistics
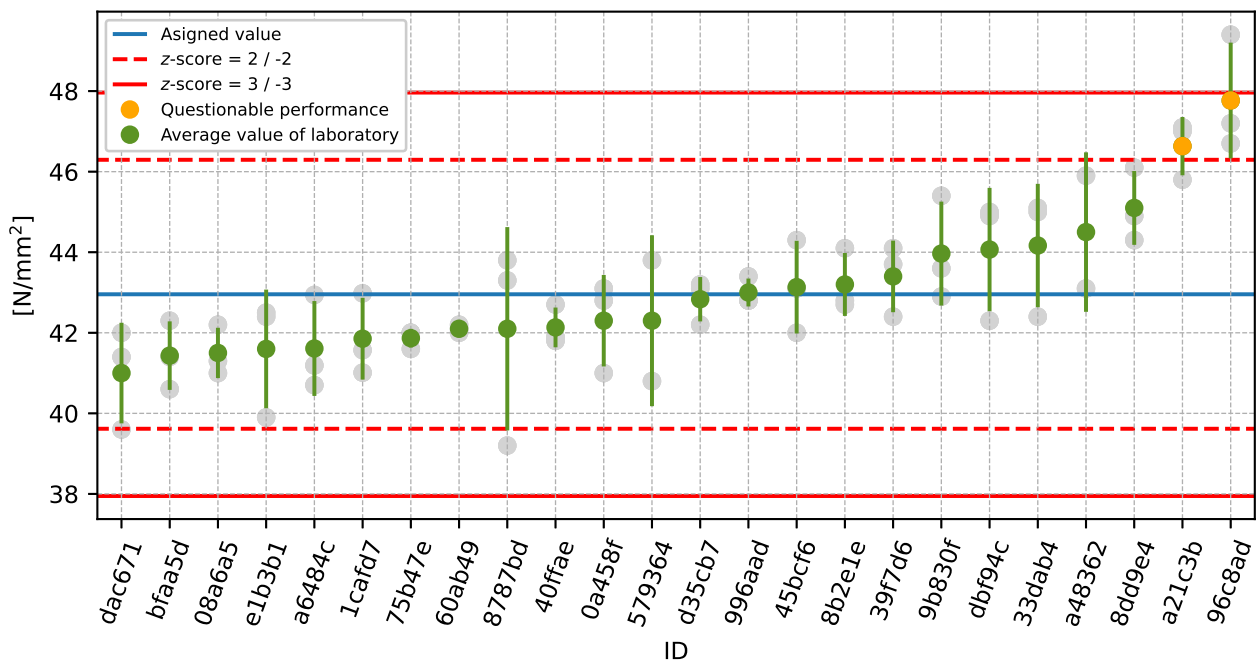
Figure 9: Average values and sample standard deviations

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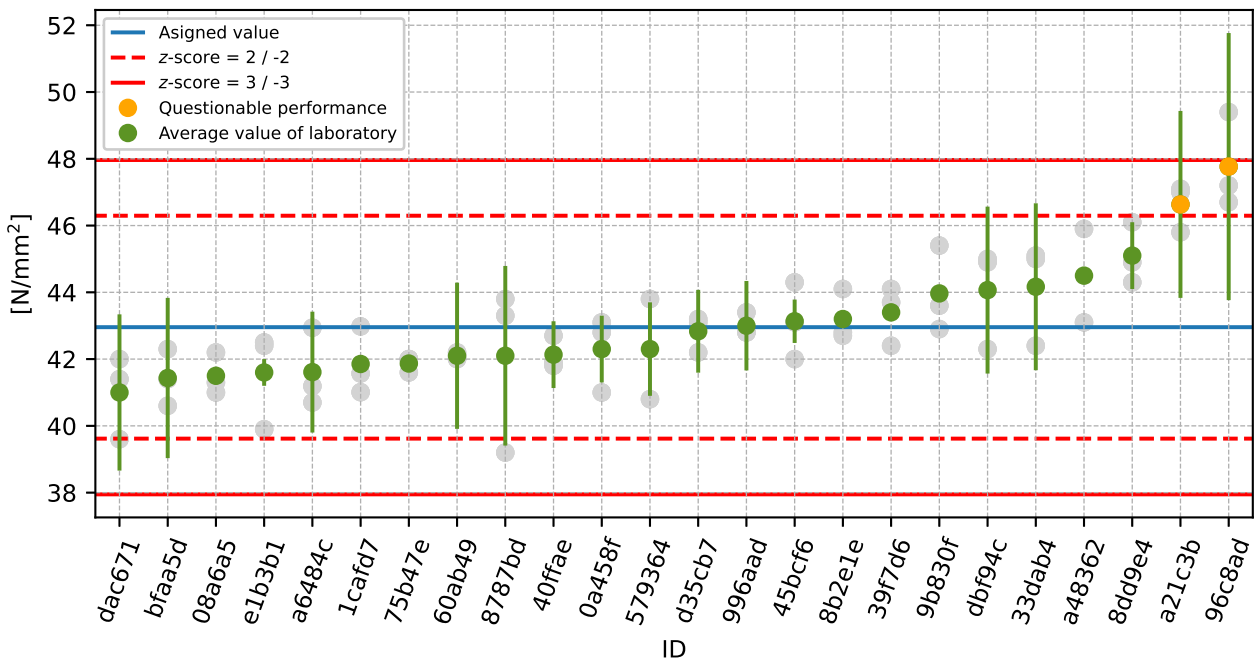
Figure 10: Average values and extended uncertainties of measurement

Figure 11: z-score

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Figure 12: ζ-score

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Table 6: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dac671	-1.17	-0.82
bfaa5d	-0.91	-0.62
08a6a5	-0.87	-
e1b3b1	-0.81	-2.32
a6484c	-0.81	-0.72
1cafd7	-0.66	-
75b47e	-0.65	-
60ab49	-0.51	-0.38
8787bd	-0.51	-0.31
40ffae	-0.49	-0.76
0a458f	-0.39	-0.6
579364	-0.39	-0.45
d35cb7	-0.07	-0.09
996aad	0.03	0.03
45bcf6	0.11	0.23
8b2e1e	0.15	0.57
39f7d6	0.27	-
9b830f	0.61	-
dbf94c	0.67	0.44
33dab4	0.73	0.48
a48362	0.92	-
8dd9e4	1.28	1.97
a21c3b	2.2	1.3
96c8ad	2.88	1.2

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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/mm²]			u_X [N/mm²]	$\bar{x}$ [N/mm²]	s_0 [N/mm²]	V_X [%]
a6484c	4.2	4.1	4.3	0.1	4.2	0.1	2.4
39f7d6	4.3	4.6	4.2	-	4.4	0.21	4.77
dbf94c	4.5	4.7	4.5	0.3	4.6	0.12	2.53
75b47e	4.8	4.8	4.7	-	4.8	0.06	1.21
35991b	5.1	4.7	4.7	0.1	4.8	0.23	4.78
5828b0	4.5	5.0	5.2	0.6	4.9	0.36	7.36
db9775	5.0	4.7	5.0	0.3	4.9	0.17	3.53
bfaa5d	5.3	5.0	4.4	1.9	4.9	0.46	9.35
8b185f	5.4	5.2	4.6	1.0	5.1	0.4	7.87

2.2   The Numerical Procedure for Determining Outliers
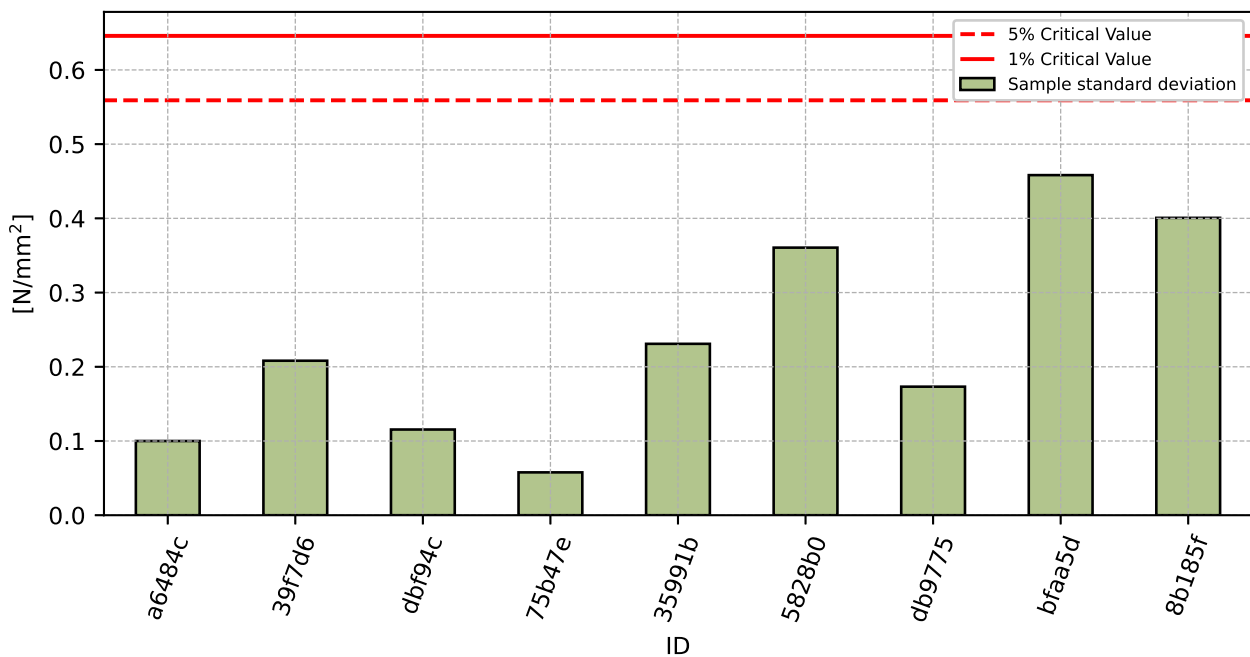
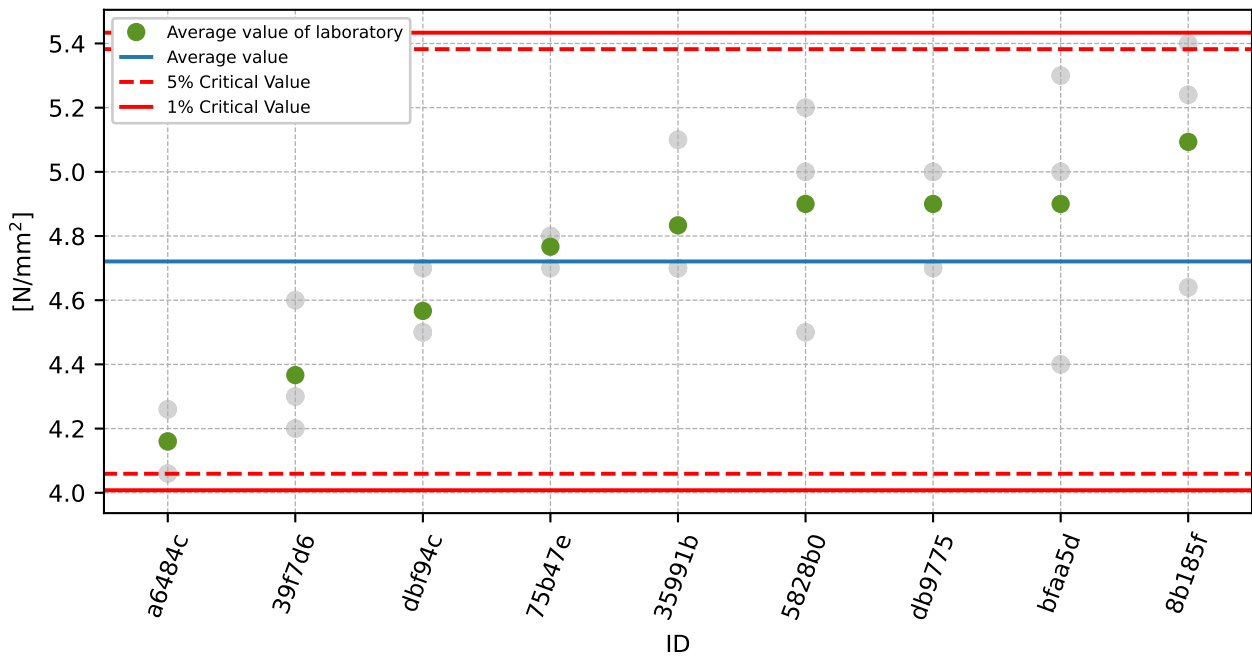Figure 13: **Cochran's test** - sample standard deviations

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Figure 14: **Grubbs' test** - average values

2.3   Mandel's Statistics
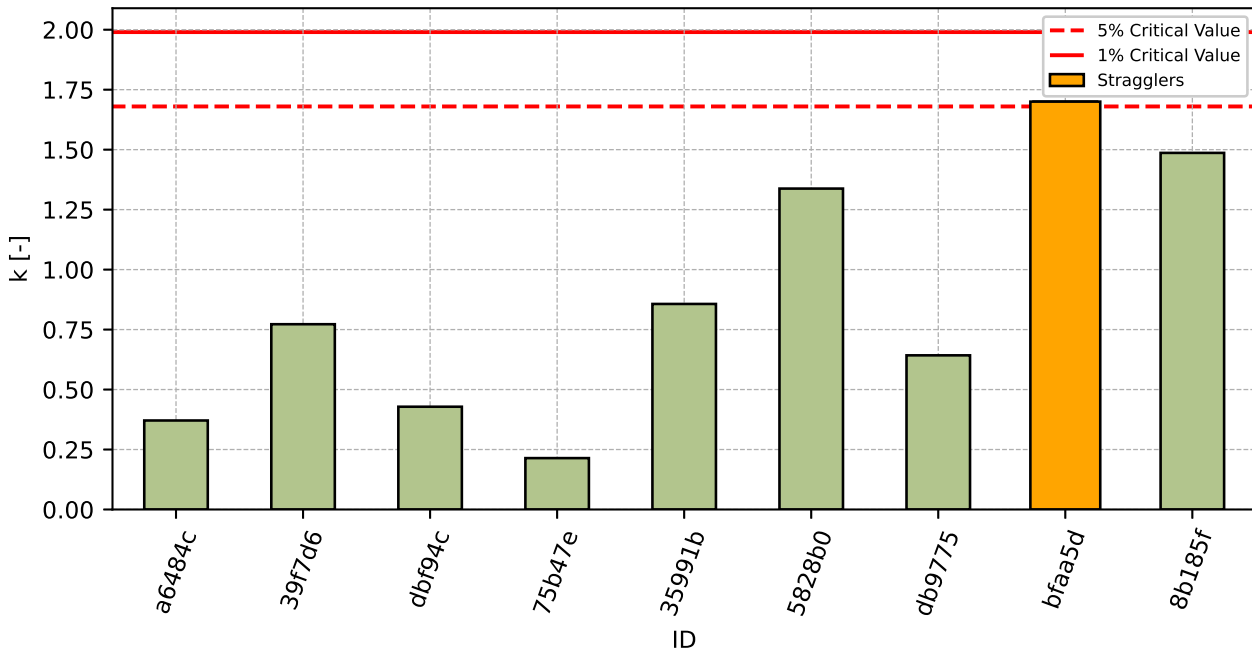
Figure 15: Intralaboratory Consistency Statistic

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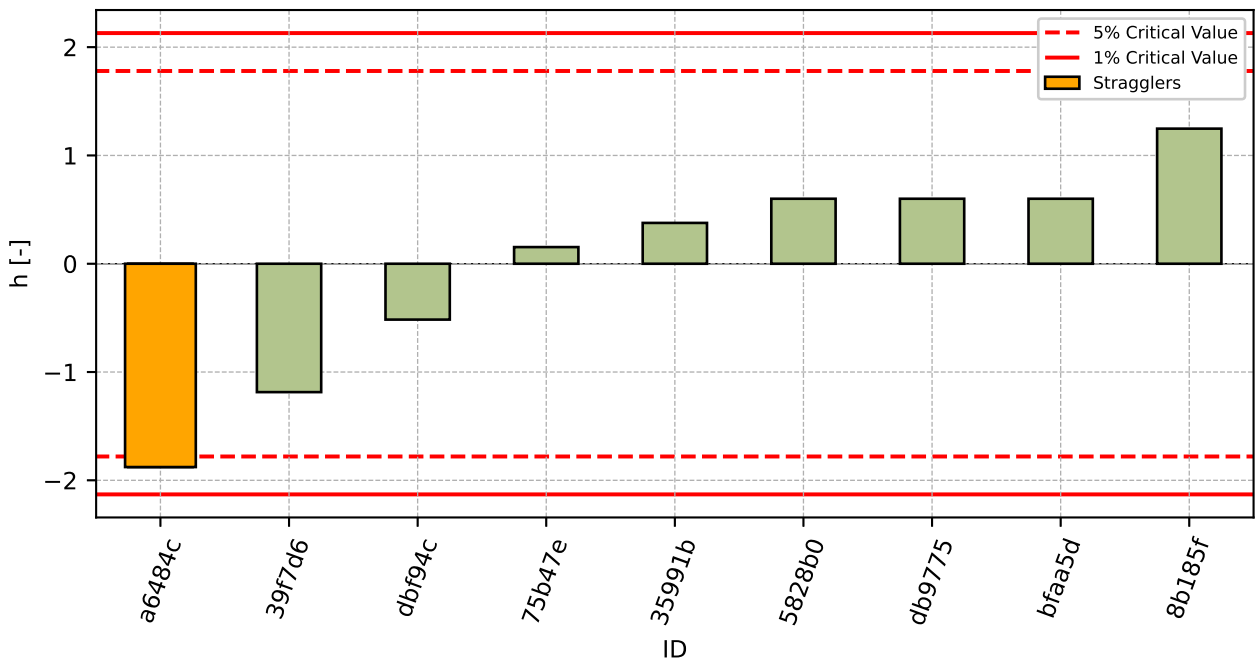
Figure 16: Interlaboratory Consistency Statistic

2.4   Descriptive statistics
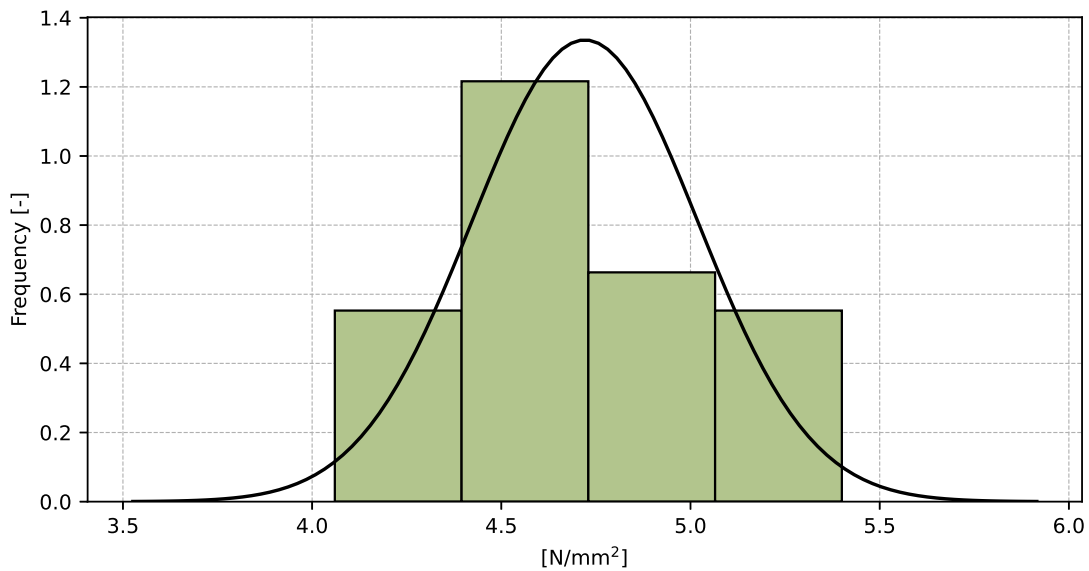
Figure 17: Histogram of all test results

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Table 8: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	4.7
Sample standard deviation – s	0.3
Asigned value – x^*	4.7
Robust standard deviation – s^*	0.3
Measurement uncertainty of asigned value – u_X	0.1
p-value of normality test	0.674 [-]
Interlaboratory standard deviation – s_L	0.21
Repeatability standard deviation – s_r	0.23
Reproducibility standard deviation – s_R	0.31
Repeatability – r	0.6
Reproducibility – R	0.9

2.5   Evaluation of Performance Statistics
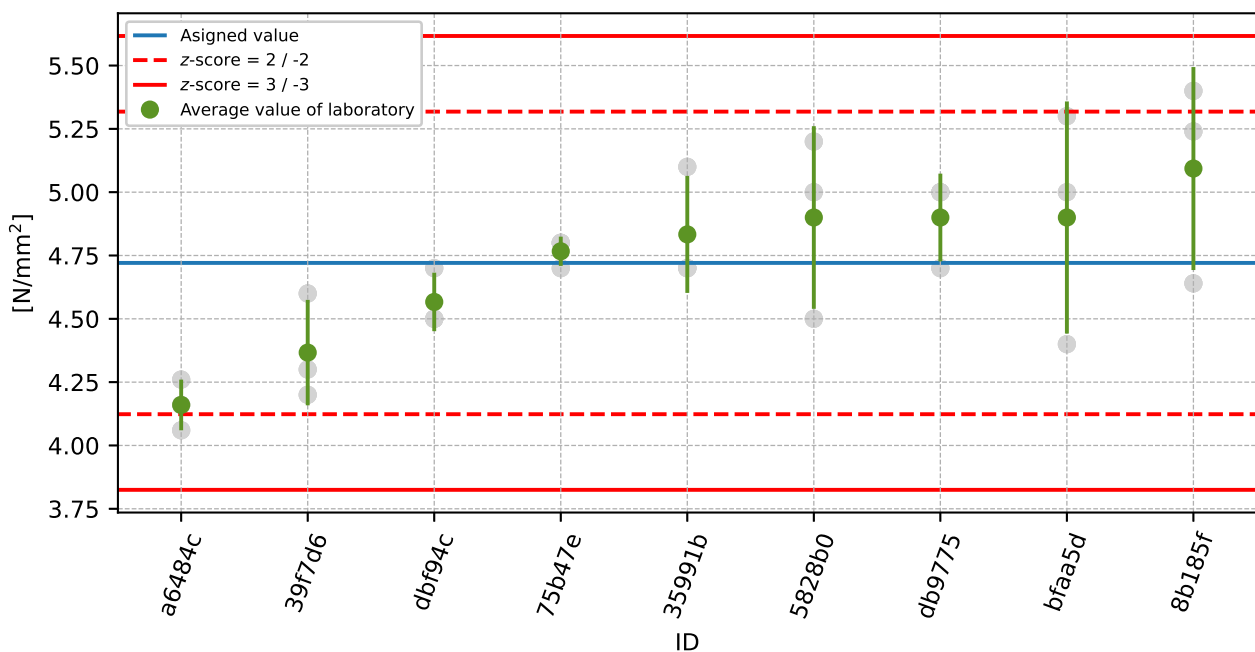
Figure 18: Average values and sample standard deviations

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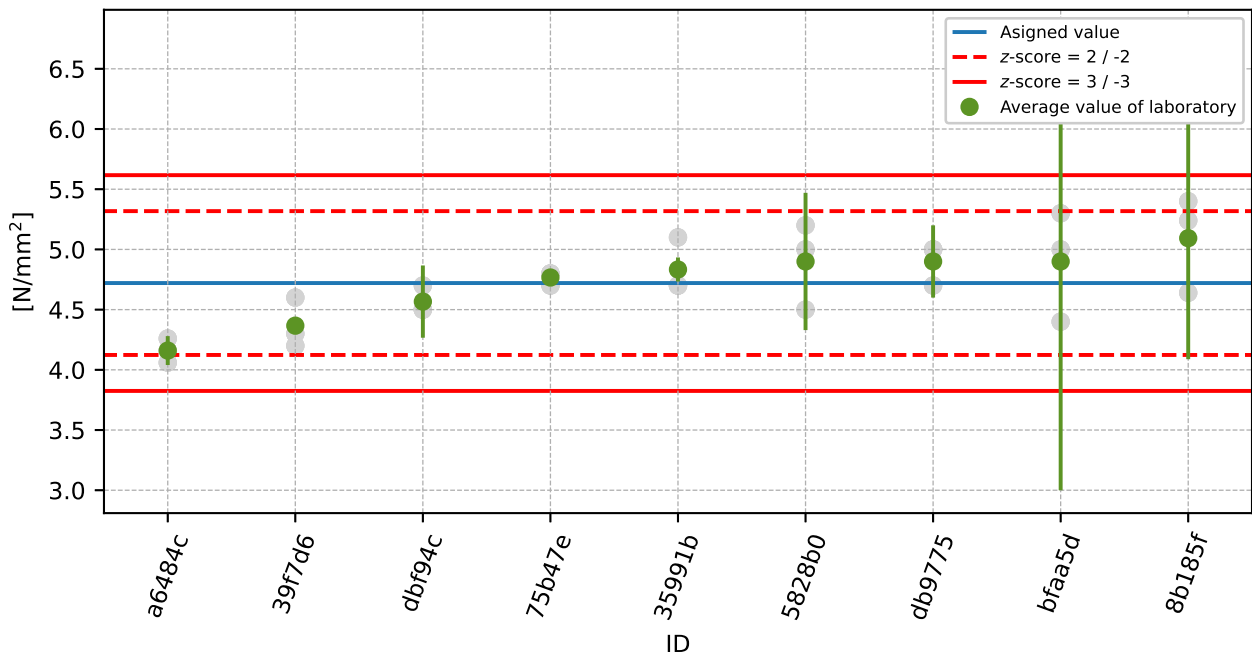
Figure 19: Average values and extended uncertainties of measurement

Figure 20: z-score

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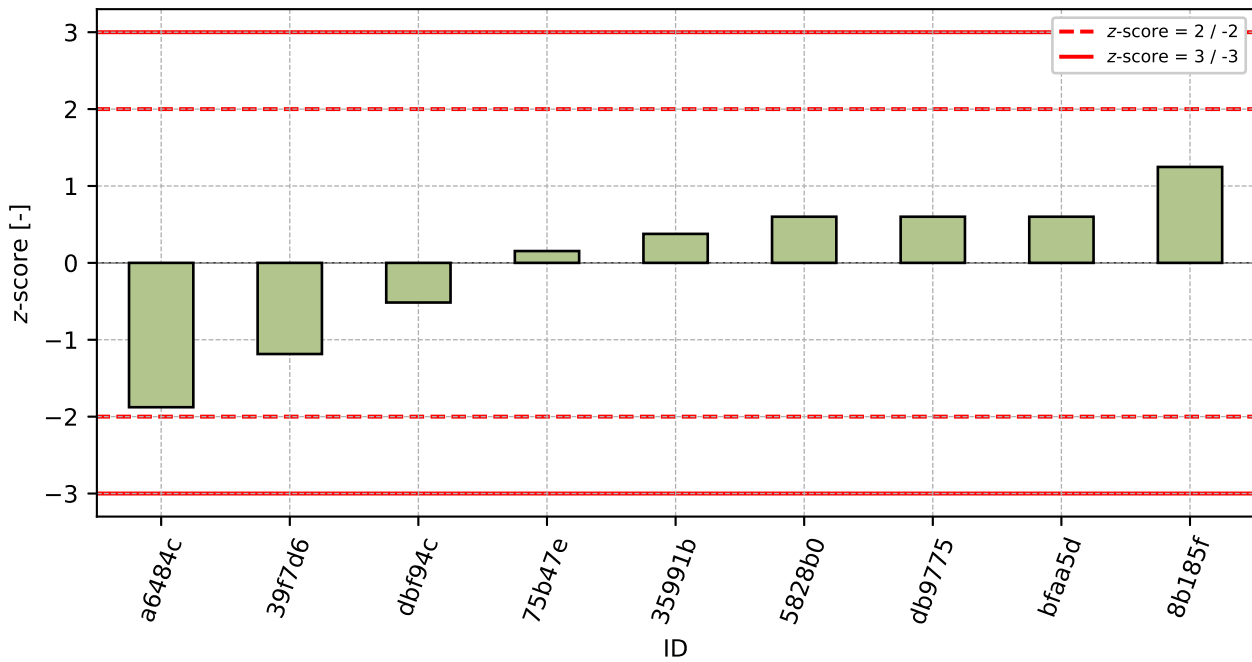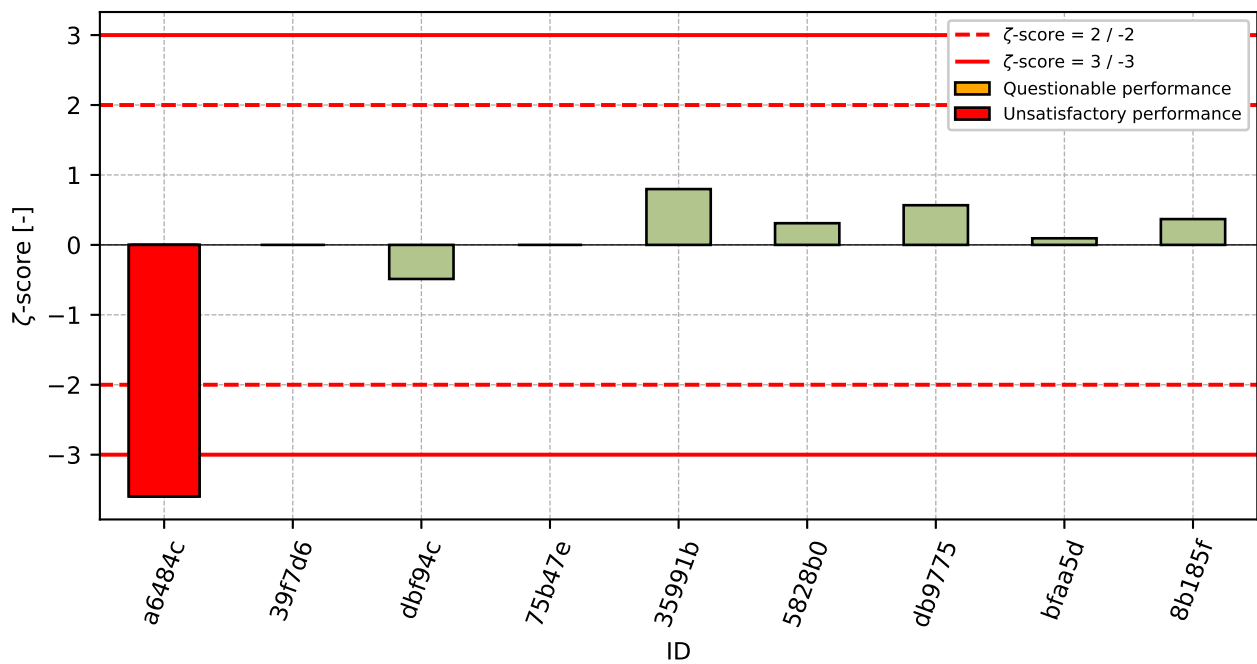
Figure 21: ζ-score

Table 9: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a6484c	-1.88	-3.6
39f7d6	-1.19	-
dbf94c	-0.52	-0.49
75b47e	0.15	-
35991b	0.38	0.8
5828b0	0.6	0.31
db9775	0.6	0.57
bfaa5d	0.6	0.09
8b185f	1.25	0.37

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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/mm²]			u_X [N/mm²]	$\bar{x}$ [N/mm²]	s_0 [N/mm²]	V_X [%]
a6484c	3.24	3.08	3.15	0.17	3.16	0.08	2.54
bfaa5d	3.09	3.15	3.71	0.2	3.32	0.342	10.31
dbf94c	3.75	3.2	3.55	0.2	3.5	0.278	7.95
ea9180	3.55	3.65	3.45	0.27	3.55	0.1	2.82
39f7d6	3.45	3.8	3.45	-	3.57	0.202	5.67
2a51a2	3.75	3.7	3.6	0.2	3.68	0.076	2.07
5828b0	3.85	3.4	4.0	0.35	3.75	0.312	8.33
db9775	3.85	3.7	3.75	0.2	3.77	0.076	2.03
7860ce	3.95	3.6	3.8	-	3.78	0.176	4.64
35991b	3.9	4.4	3.75	0.05	4.02	0.34	8.47

3.2   The Numerical Procedure for Determining Outliers
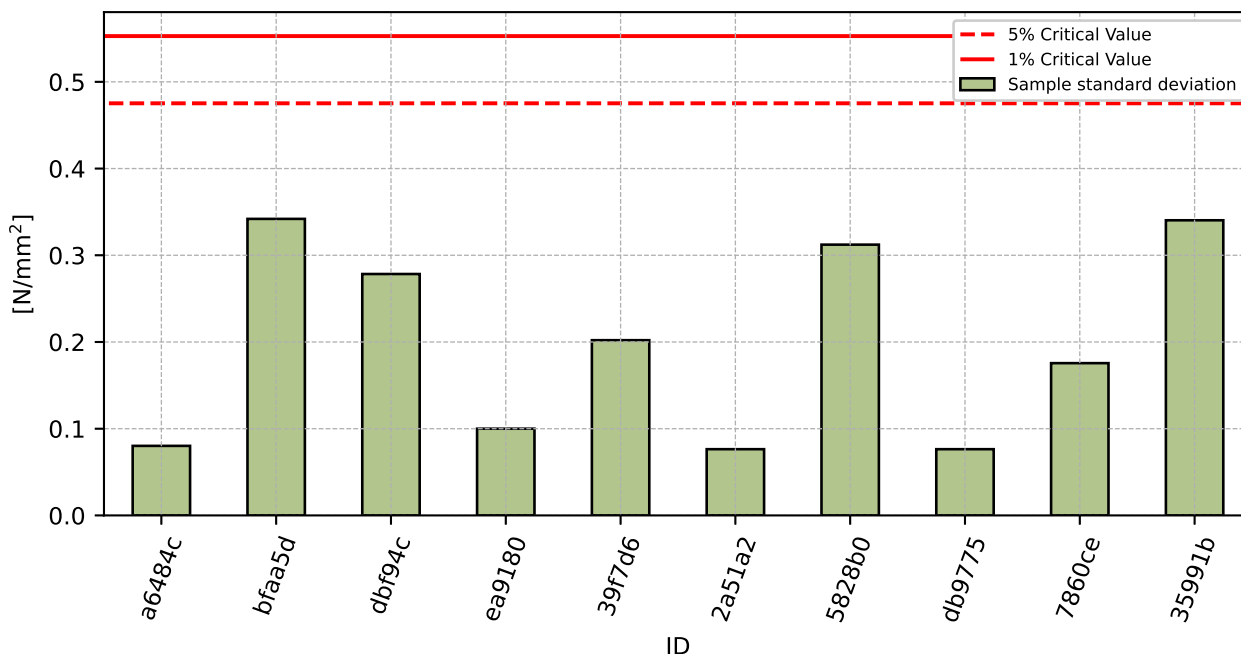
Figure 22: **Cochran's test** - sample standard deviations

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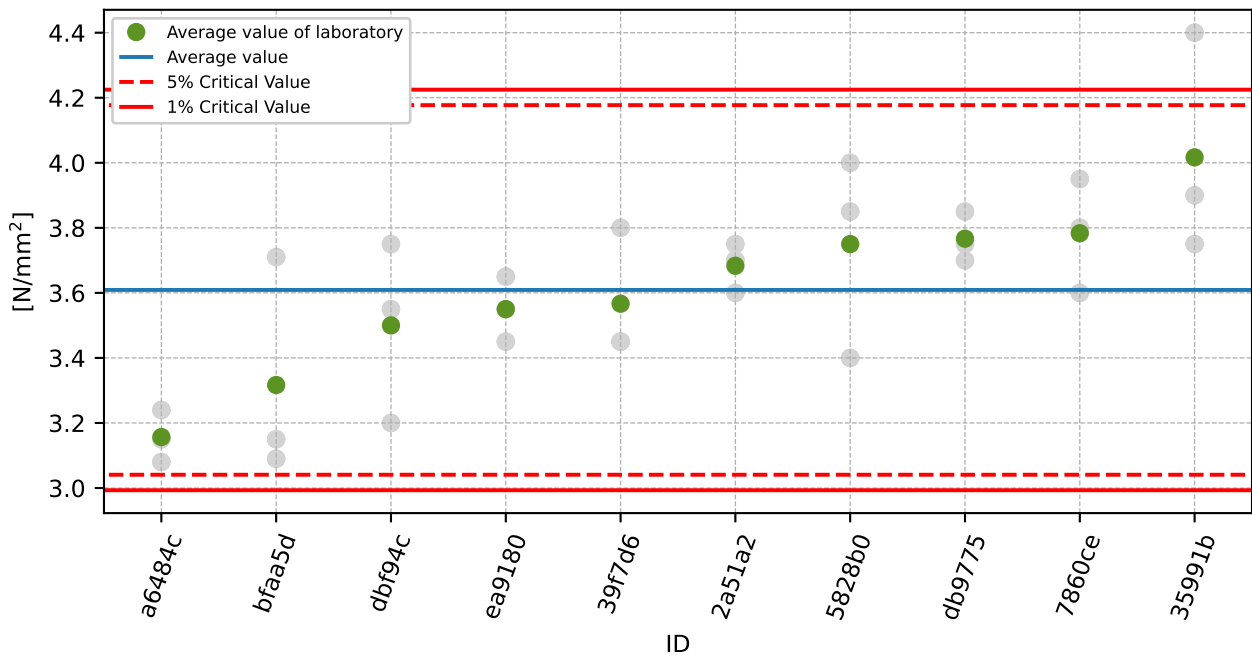Veveří 331/95 | 602 00 Brno | Czech Republic
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Figure 23: **Grubbs' test** - average values

3.3   Mandel's Statistics
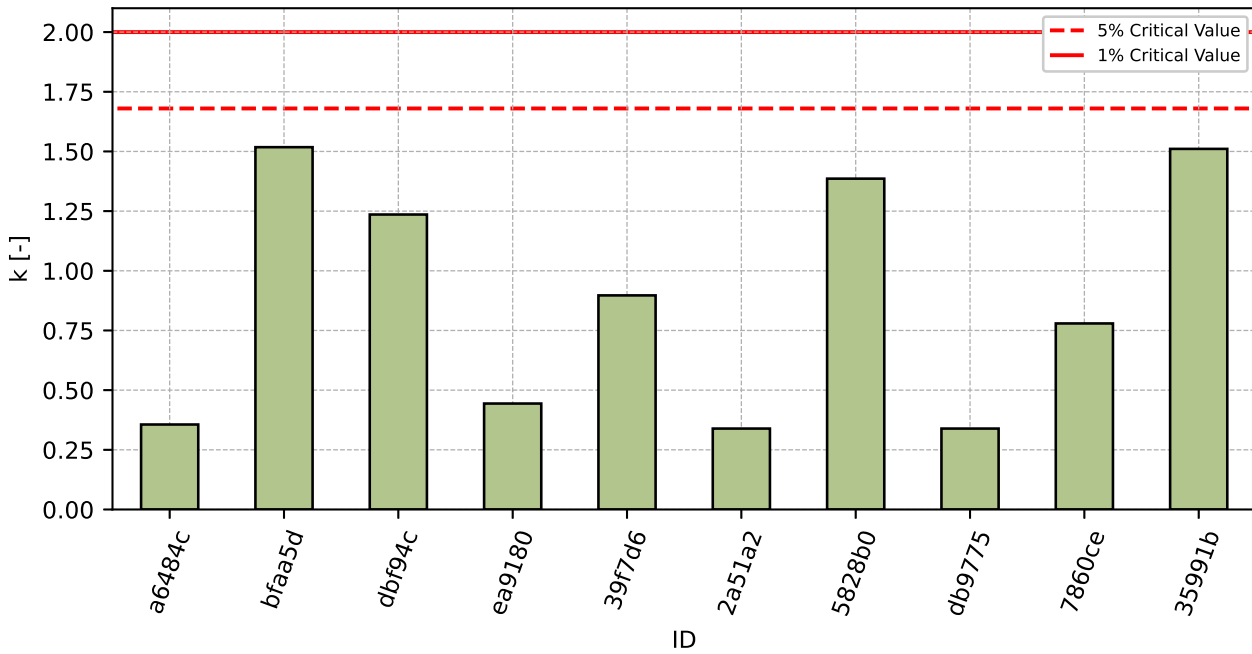
Figure 24: Intralaboratory Consistency Statistic

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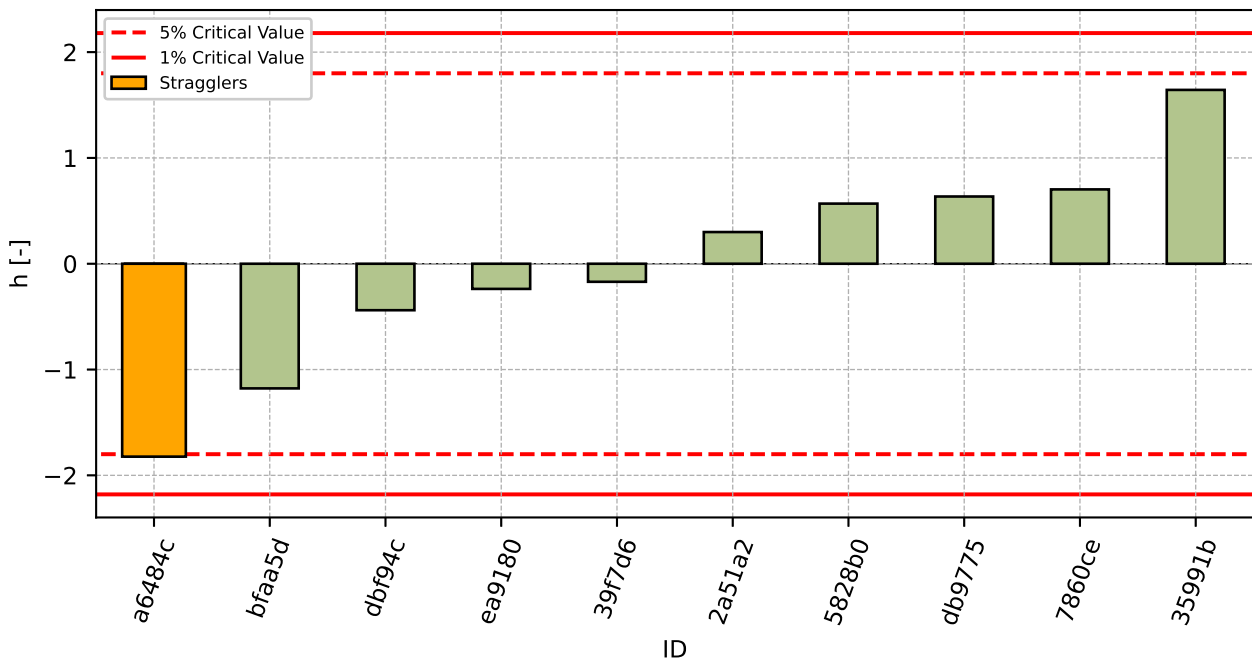Veveří 331/95 | 602 00 Brno | Czech Republic
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Figure 25: Interlaboratory Consistency Statistic

3.4   Descriptive statistics
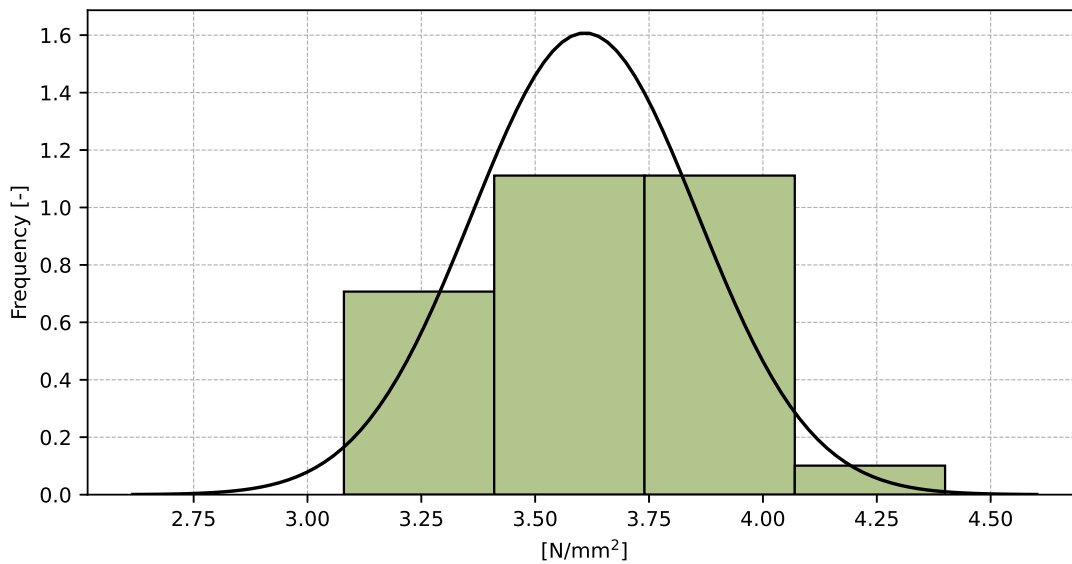
Figure 26: Histogram of all test results

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Table 11: Descriptive statistics

Characteristics	[N/mm^2]
Average value – $\bar{x}$	3.61
Sample standard deviation – s	0.248
Asigned value – x^*	3.63
Robust standard deviation – s^*	0.242
Measurement uncertainty of asigned value – u_X	0.092
p-value of normality test	0.22 [-]
Interlaboratory standard deviation – s_L	0.211
Repeatability standard deviation – s_r	0.225
Reproducibility standard deviation – s_R	0.309
Repeatability – r	0.63
Reproducibility – R	0.86

3.5   Evaluation of Performance Statistics
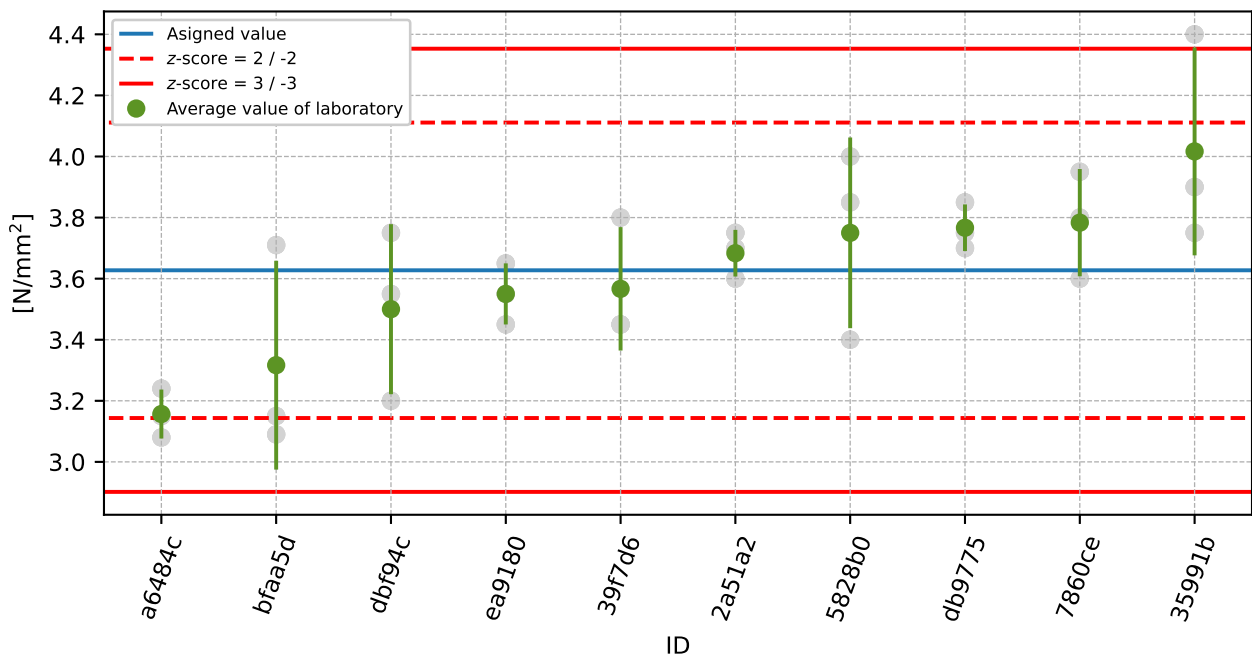
Figure 27: Average values and sample standard deviations

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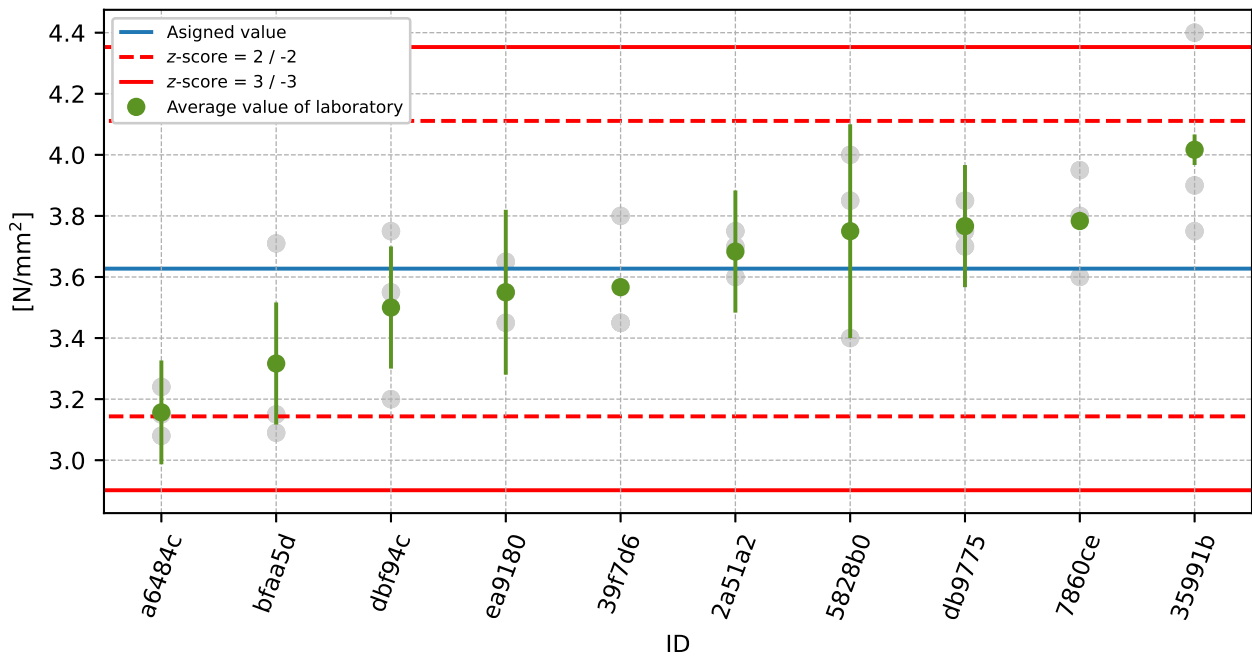
Figure 28: Average values and extended uncertainties of measurement

Figure 29: z-score

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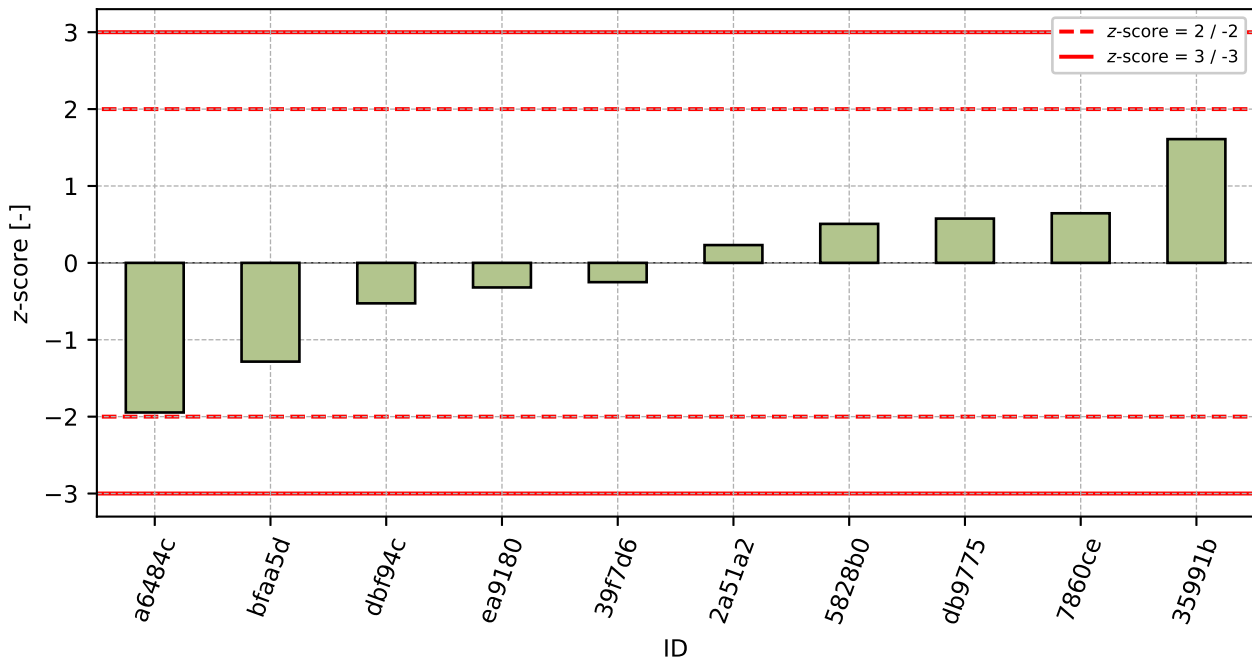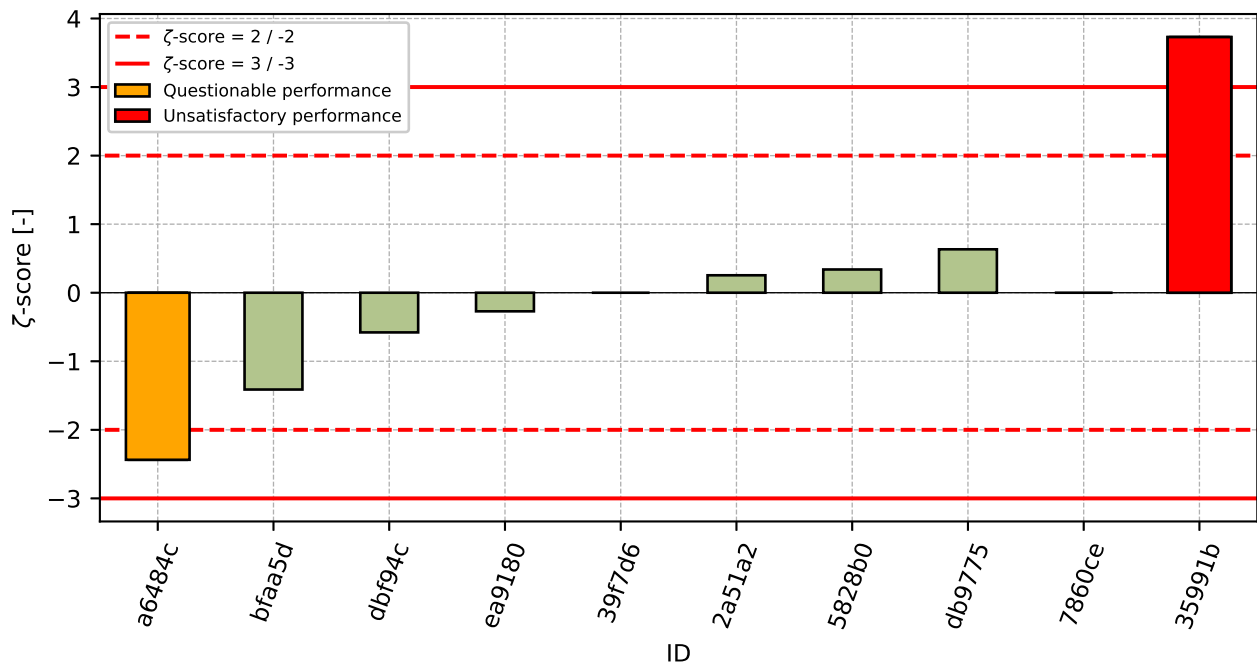
Figure 30: ζ-score

Table 12: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
a6484c	-1.95	-2.44
bfaa5d	-1.28	-1.41
dbf94c	-0.53	-0.58
ea9180	-0.32	-0.27
39f7d6	-0.25	-
2a51a2	0.23	0.25
5828b0	0.51	0.34
db9775	0.58	0.63
7860ce	0.64	-
35991b	1.61	3.73

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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/m³]			u_X [kg/m³]	$\bar{x}$ [kg/m³]	s_0 [kg/m³]	V_X [%]
996aad	2264	2253	2257	3	2258	5.6	0.25
75b47e	2260	2270	2260	-	2263	5.8	0.26
a6484c	2263	2277	2264	52	2268	7.8	0.34
9b830f	2270	2280	2260	-	2270	10.0	0.44
35991b	2267	2275	2275	20	2272	4.6	0.2
bfaa5d	2280	2280	2260	20	2273	11.5	0.51
60ab49	2280	2280	2270	46	2277	5.8	0.25
39f7d6	2270	2280	2280	-	2277	5.8	0.25
08a6a5	2290	2280	2270	-	2280	10.0	0.44
96c8ad	2290	2270	2280	40	2280	10.0	0.44
dbf94c	2280	2290	2270	20	2280	10.0	0.44
8dd9e4	2290	2270	2280	10	2280	10.0	0.44
8787bd	2282	2277	2284	27	2281	3.6	0.16
0a458f	2283	2277	2285	50	2282	4.2	0.18
1cafd7	2282	2287	2285	-	2285	2.5	0.11
dac671	2290	2290	2280	21	2287	5.8	0.25
a21c3b	2300	2280	2290	40	2290	10.0	0.44
33dab4	2290	2320	2300	13	2303	15.3	0.66
a48362	2303	2320	2296	-	2306	12.3	0.54

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4.2 The Numerical Procedure for Determining Outliers
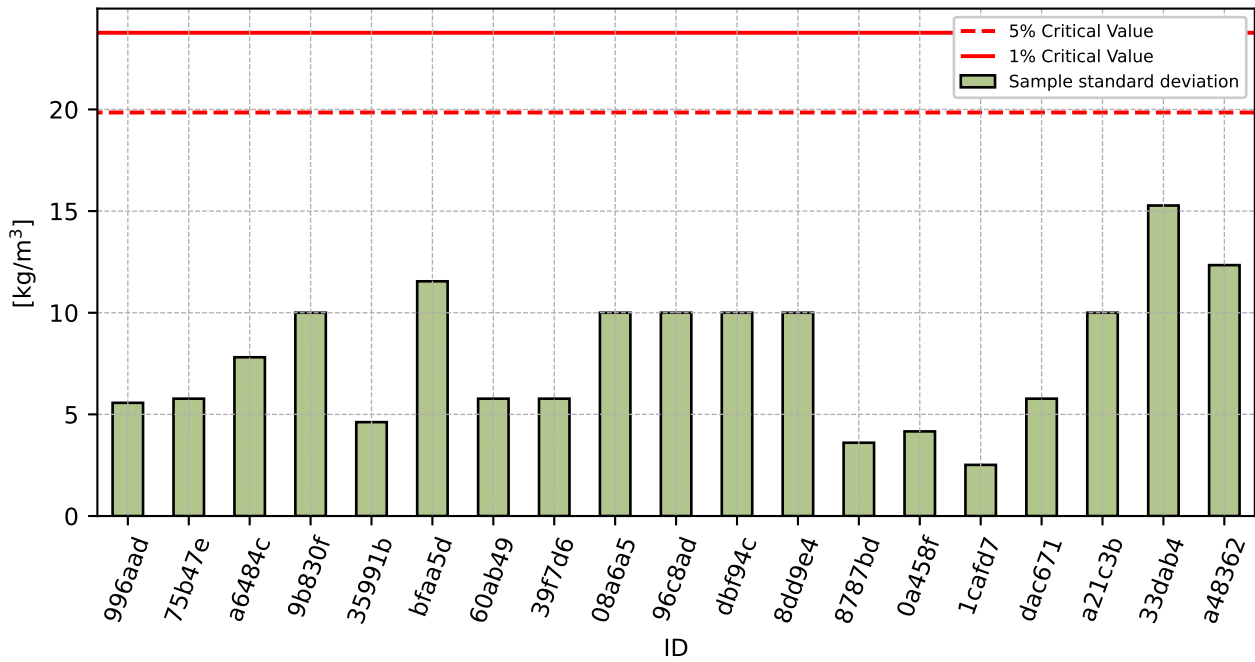
Figure 31: **Cochran's test** - sample standard deviations

Figure 32: **Grubbs' test** - average values
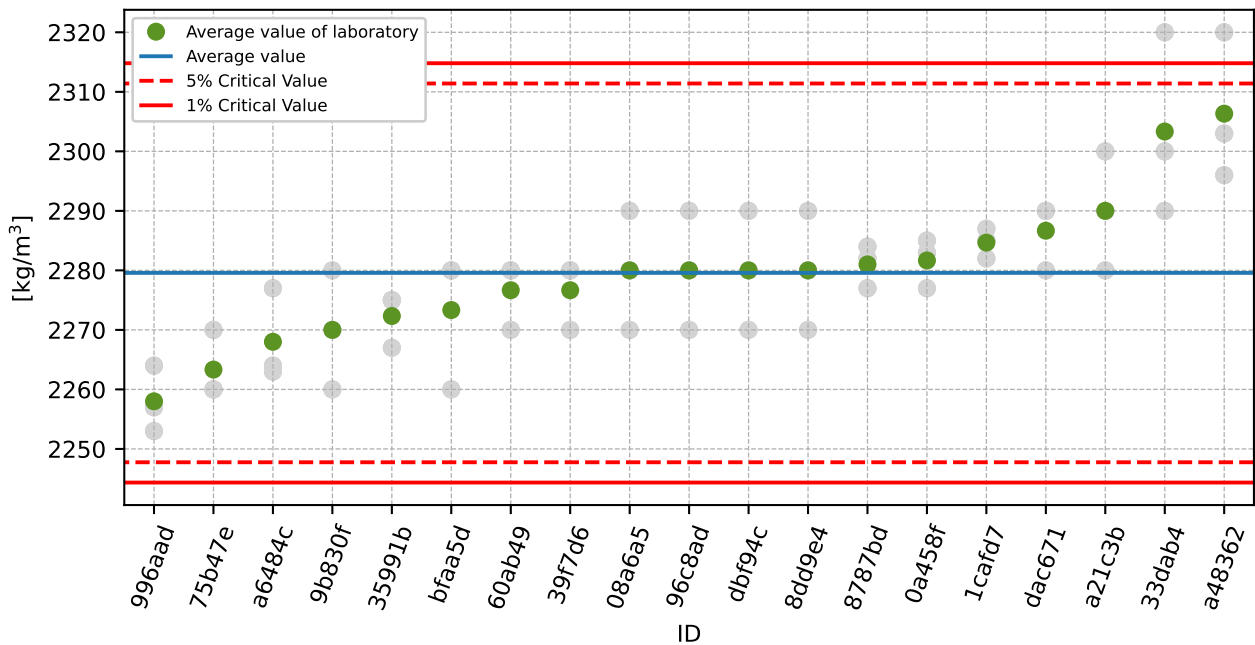
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4.3   Mandel′s Statistics
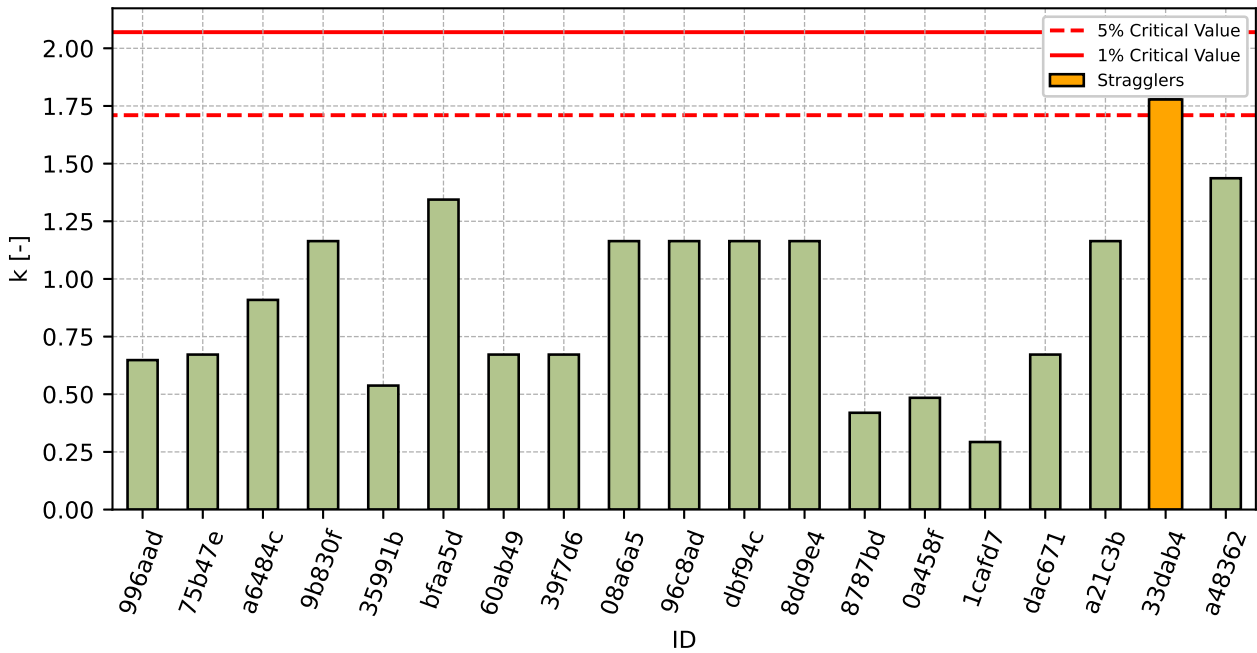
Figure 33: Intralaboratory Consistency Statistic
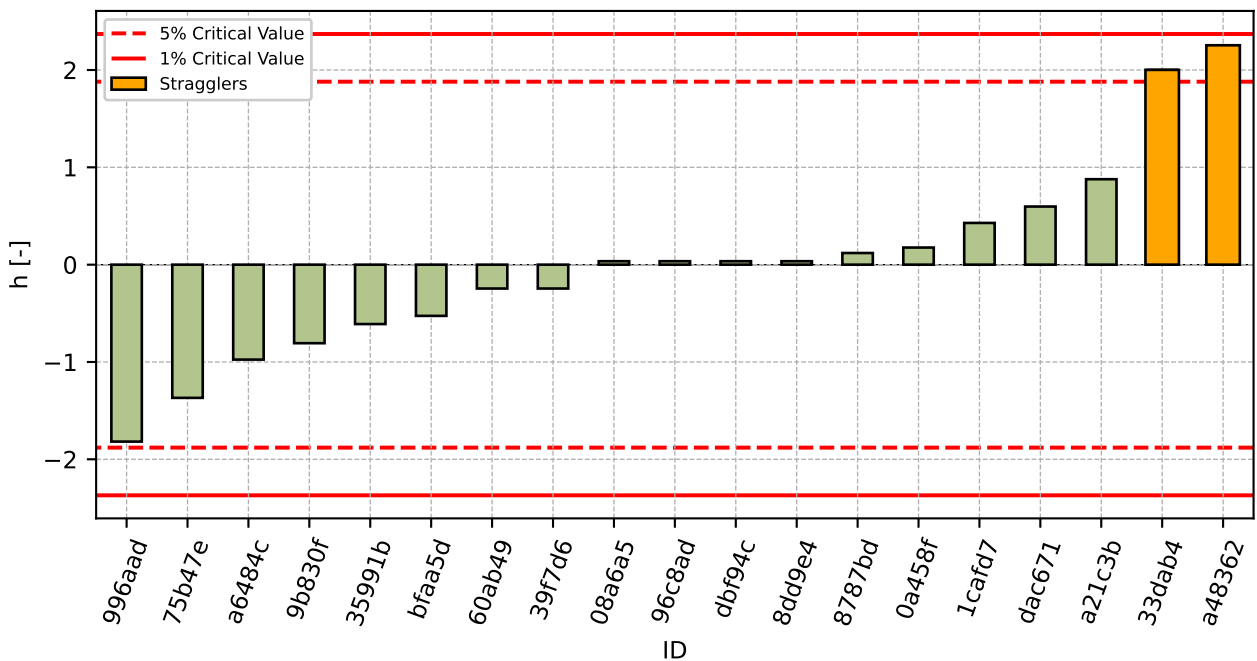
Figure 34: Interlaboratory Consistency Statistic

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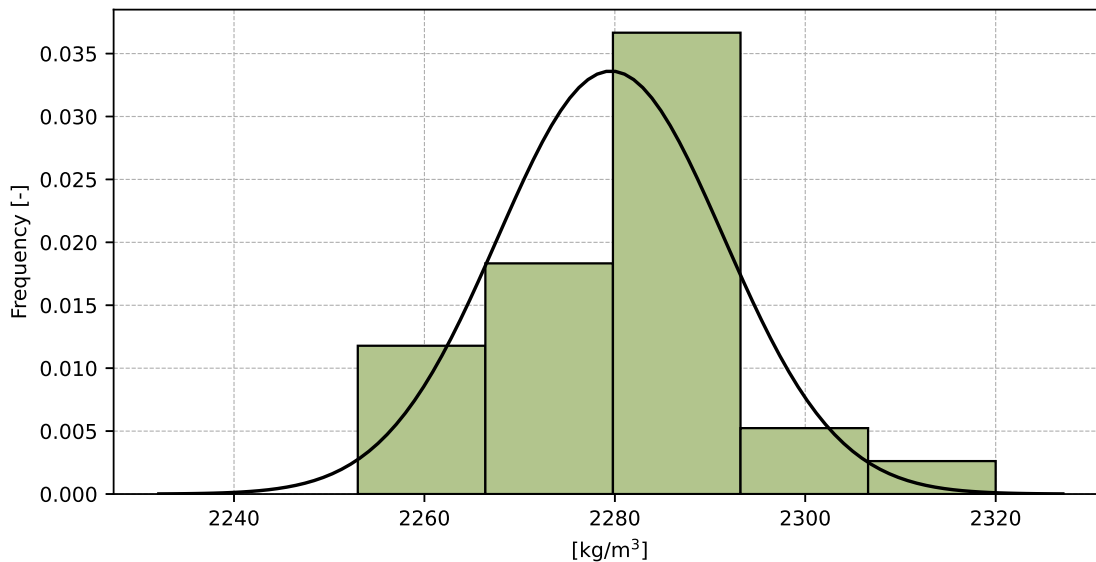Veveří 331/95 | 602 00 Brno | Czech Republic
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4.4   Descriptive statistics

Figure 35: Histogram of all test results

Table 14: Descriptive statistics

Characteristics	[kg/m³]
Average value – $\bar{x}$	2280.0
Sample standard deviation – s	11.9
Asigned value – x^*	2280.0
Robust standard deviation – s^*	13.6
Measurement uncertainty of asigned value – u_X	3.1
p-value of normality test	0.014 [-]
Interlaboratory standard deviation – s_L	1.5
Repeatability standard deviation – s_r	1.2
Reproducibility standard deviation – s_R	2.0
Repeatability – r	3.0
Reproducibility – R	5.0

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4.5   Evaluation of Performance Statistics
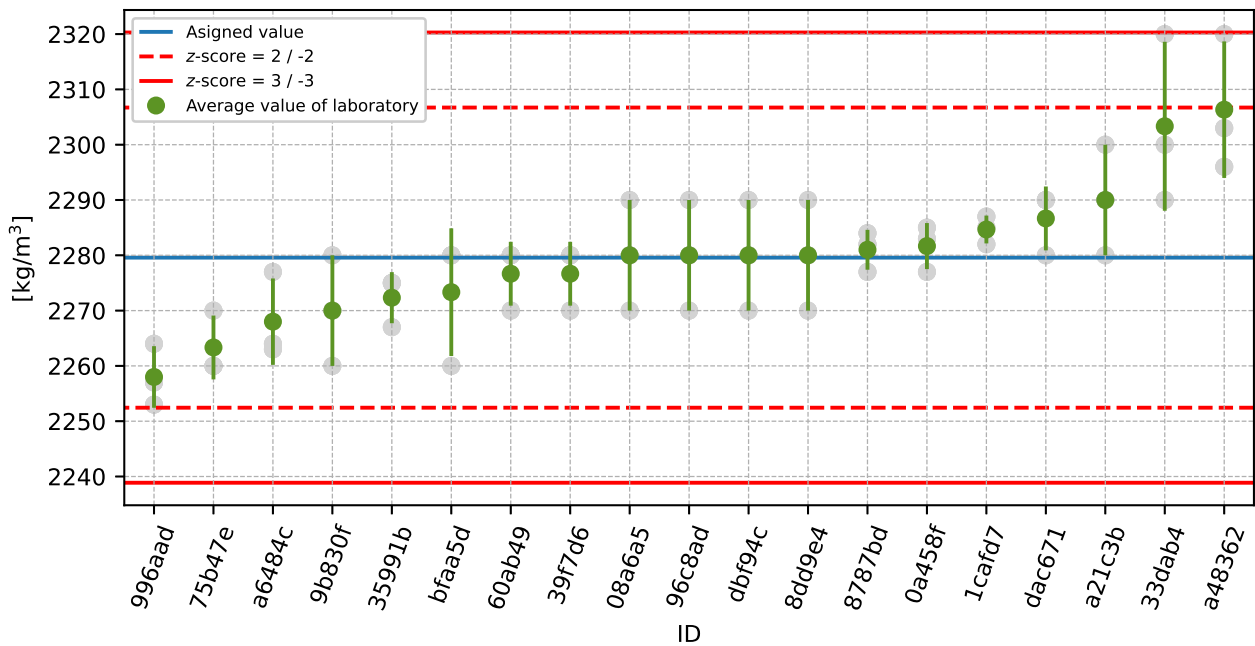

Figure 36: Average values and sample standard deviations
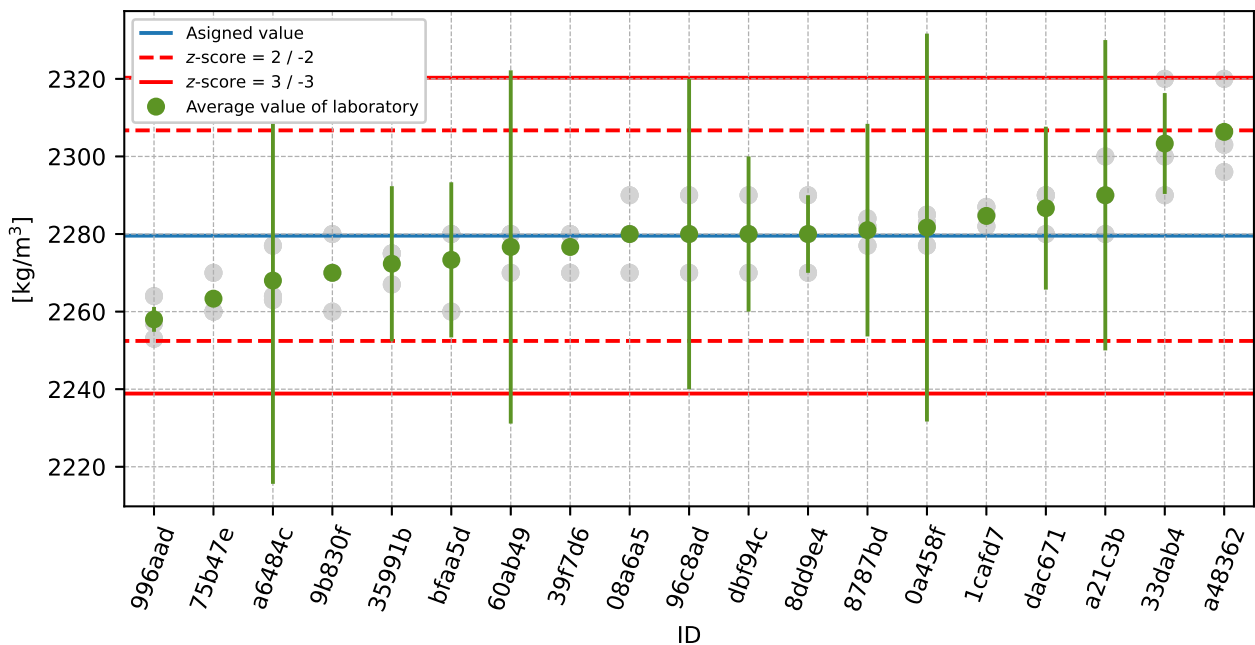
Figure 37: Average values and extended uncertainties of measurement

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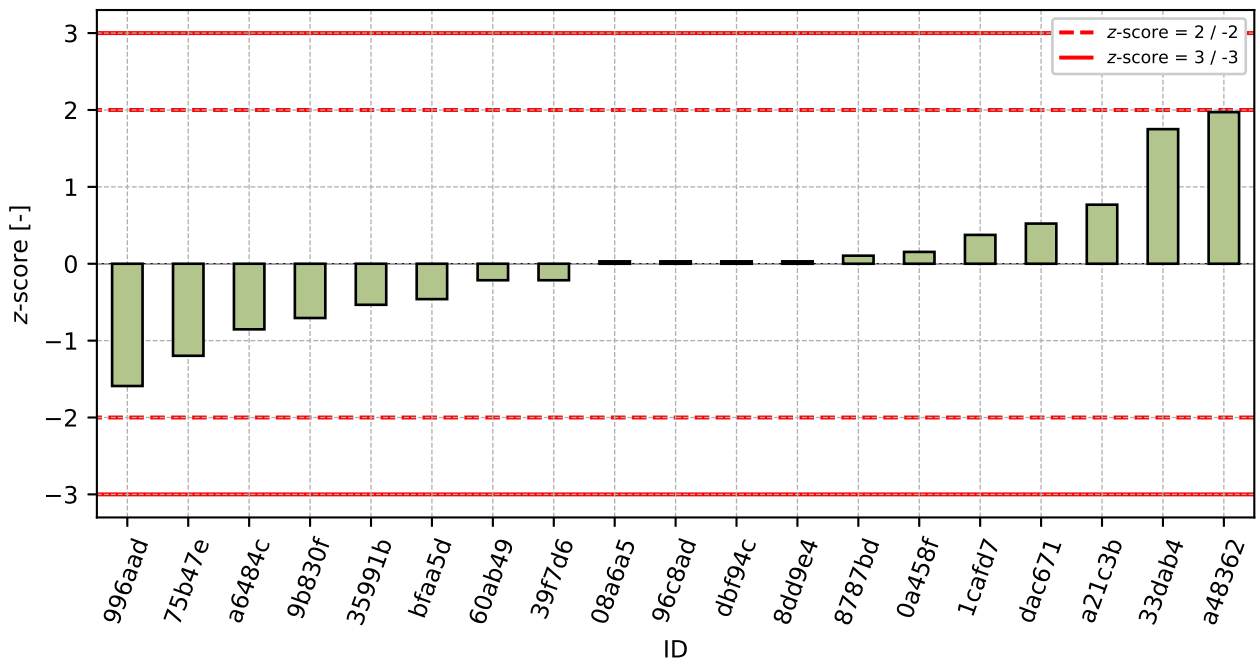
Figure 38: z-score

Figure 39: ζ-score

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Table 15: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
996aad	-1.59	-4.83
75b47e	-1.2	-
a6484c	-0.85	-0.22
9b830f	-0.71	-
35991b	-0.53	-0.36
bfaa5d	-0.46	-0.31
60ab49	-0.21	-0.06
39f7d6	-0.21	-
08a6a5	0.03	-
96c8ad	0.03	0.01
dbf94c	0.03	0.02
8dd9e4	0.03	0.04
8787bd	0.1	0.05
0a458f	0.15	0.04
1cafd7	0.37	-
dac671	0.52	0.33
a21c3b	0.77	0.26
33dab4	1.75	1.78
a48362	1.97	-

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

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

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.

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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 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			u_X	$\bar{x}$	s_0	V_X
	[-]			[-]	[-]	[-]	[%]
dbf94c	30	30	30	3	30	0.0	0.0
8b2e1e	30	32	33	2	32	1.5	4.82
60ab49	32	34	33	2	33	1.0	3.03
bfaa5d	35	35	35	5	35	0.0	0.0
7860ce	36	36	35	-	36	0.6	1.62
db9775	38	36	37	2	37	1.0	2.7

9.2   The Numerical Procedure for Determining Outliers
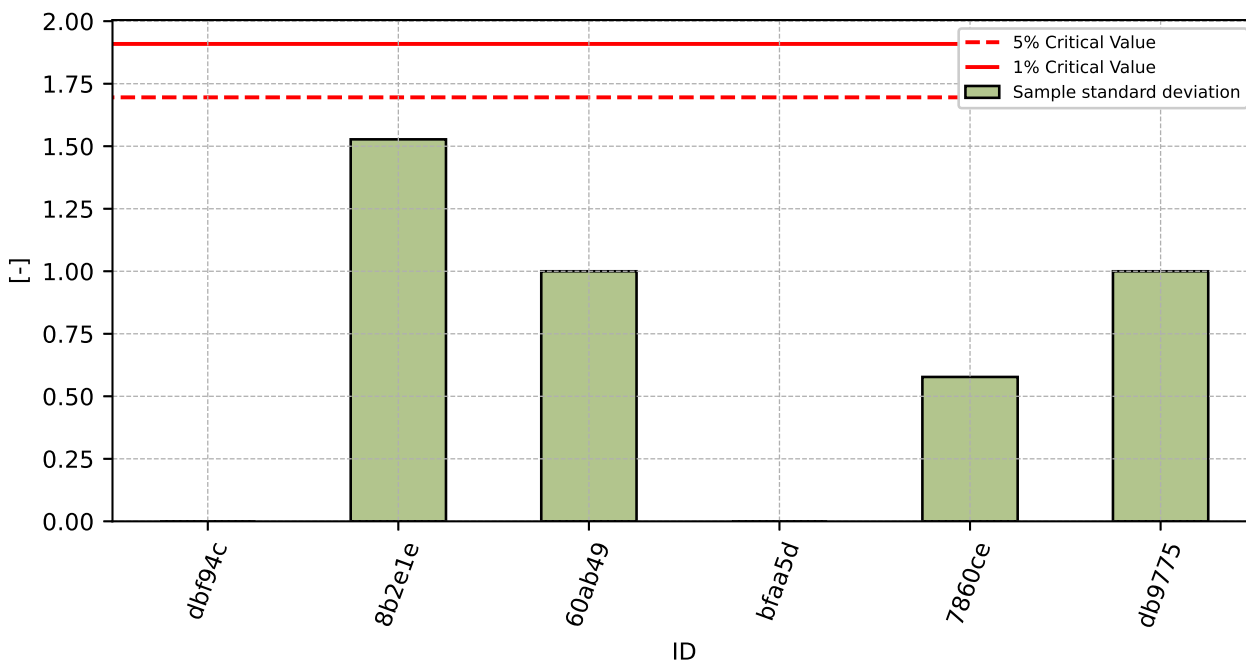
Figure 40: **Cochran's test** - sample standard deviations

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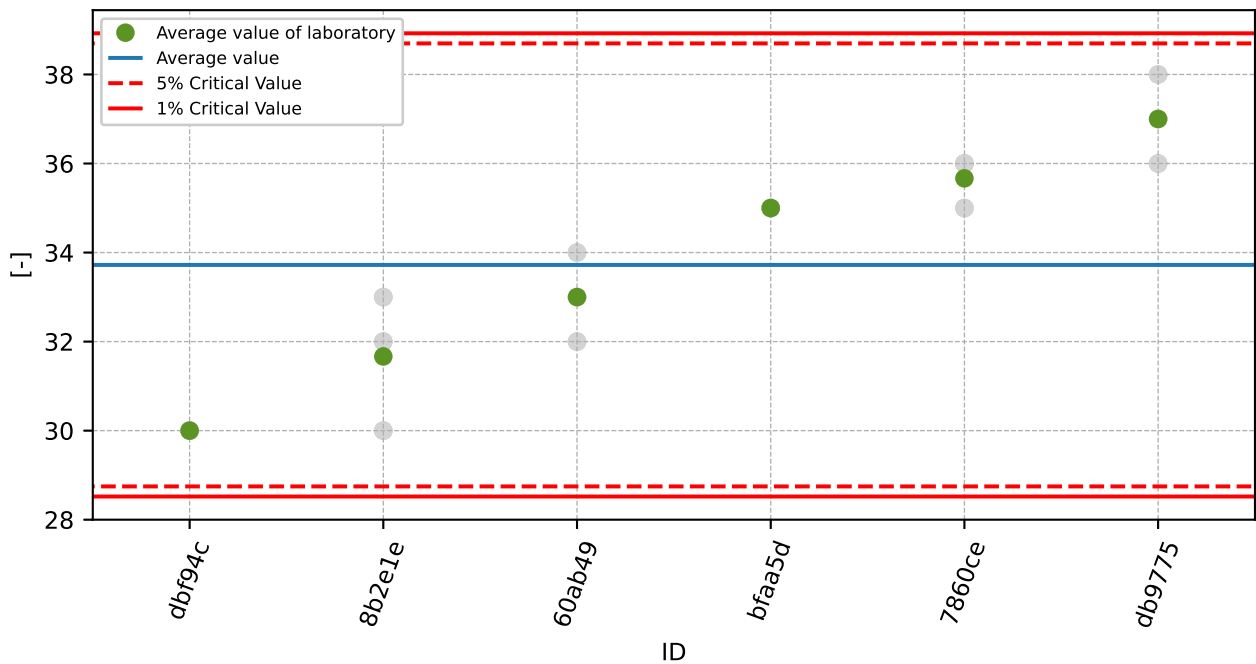szk.fce.vutbr.cz | ptprovider.cz

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

9.3   Mandel's Statistics
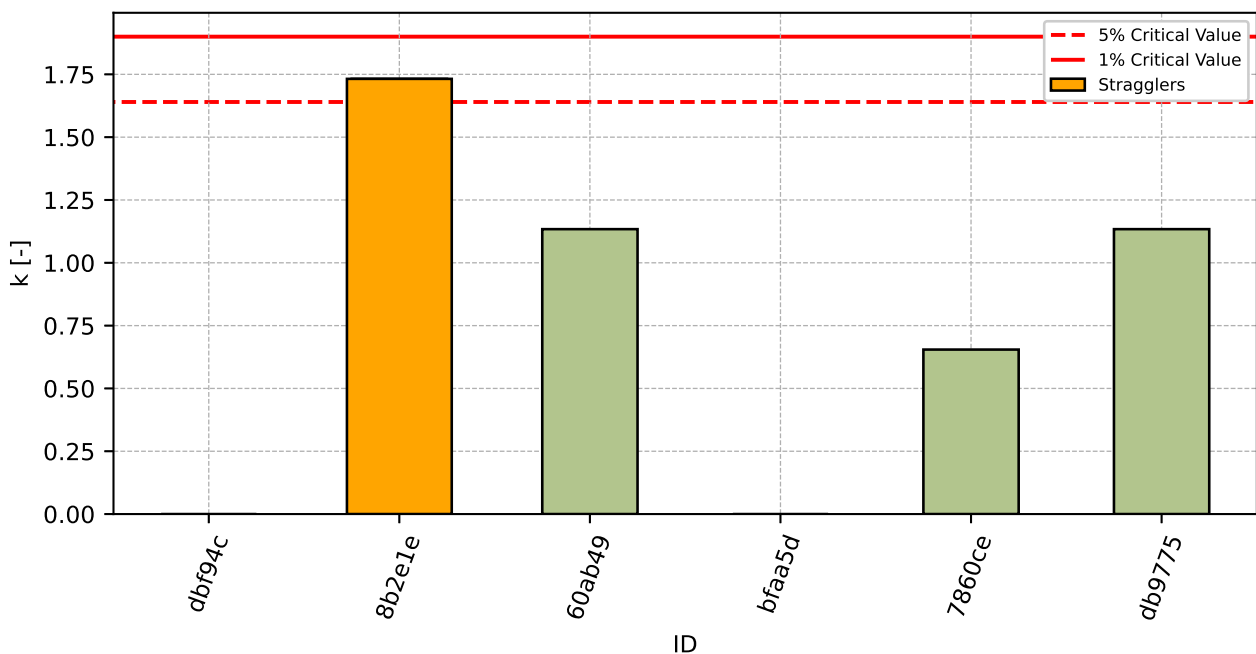
Figure 42: Intralaboratory Consistency Statistic

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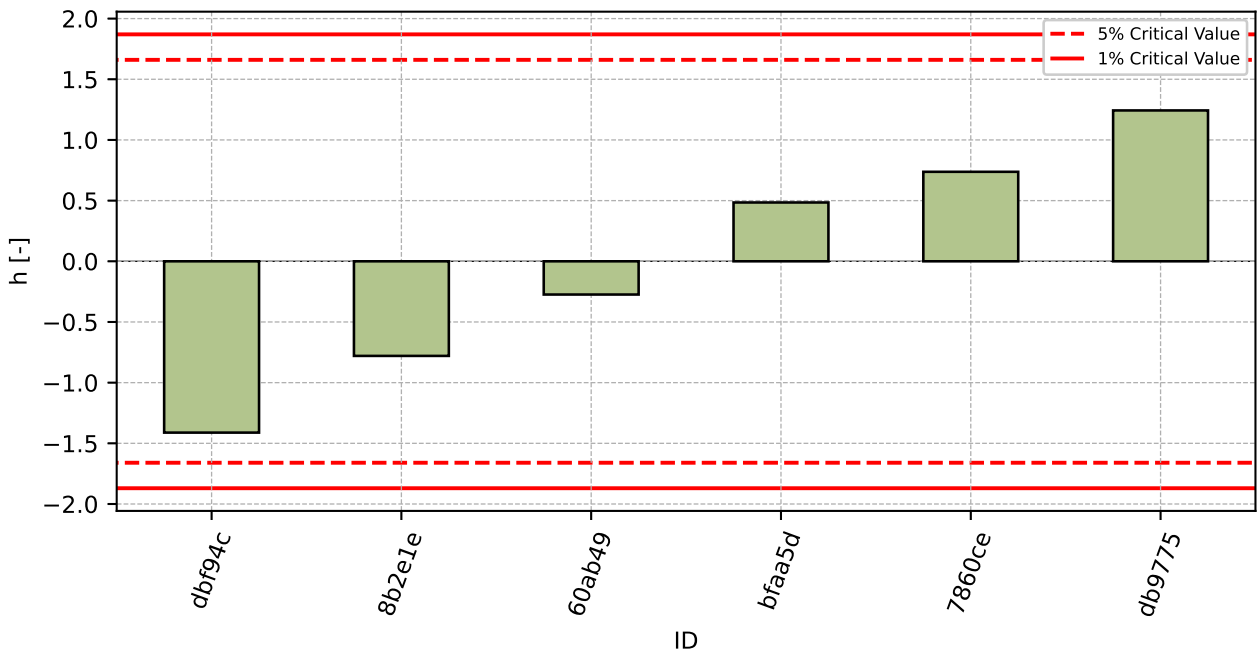**Veveří 331/95 | 602 00 Brno | Czech Republic**
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Figure 43: Interlaboratory Consistency Statistic

9.4   Descriptive statistics
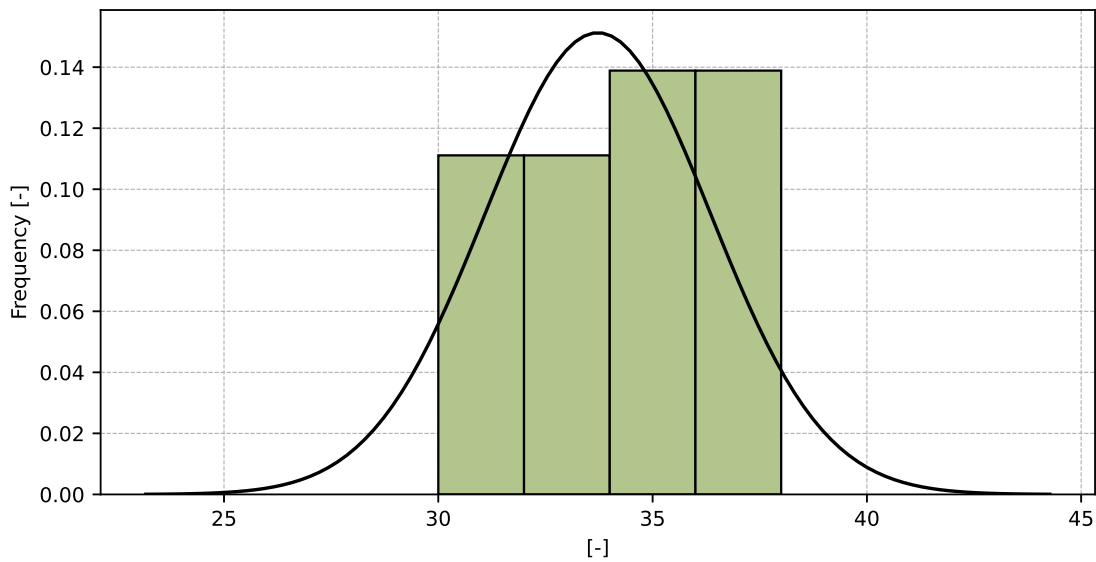
Figure 44: Histogram of all test results

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Table 17: Descriptive statistics

Characteristics	[-]
Average value – $\bar{x}$	34.0
Sample standard deviation – s	2.6
Asigned value – x^*	34.0
Robust standard deviation – s^*	2.7
Measurement uncertainty of asigned value – u_X	1.4
p-value of normality test	0.117 [-]
Interlaboratory standard deviation – s_L	0.2
Repeatability standard deviation – s_r	0.2
Reproducibility standard deviation – s_R	0.3
Repeatability – r	1.0
Reproducibility – R	1.0

9.5   Evaluation of Performance Statistics
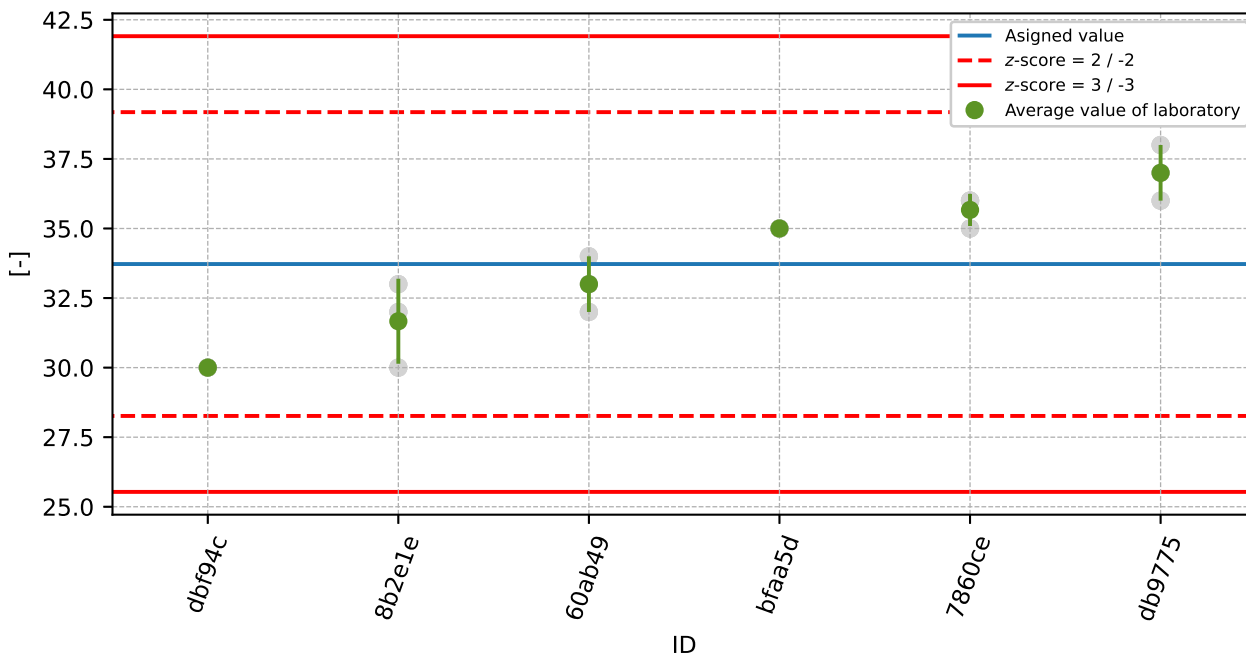
Figure 45: Average values and sample standard deviations

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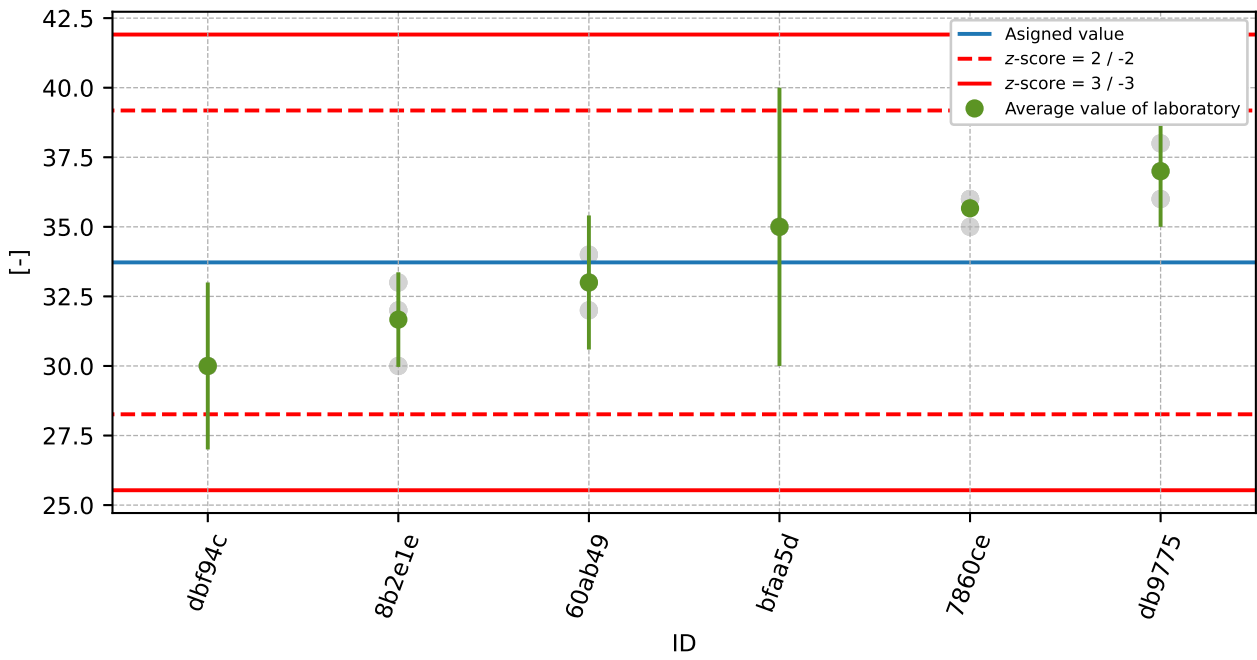
Figure 46: Average values and extended uncertainties of measurement

Figure 47: z-score

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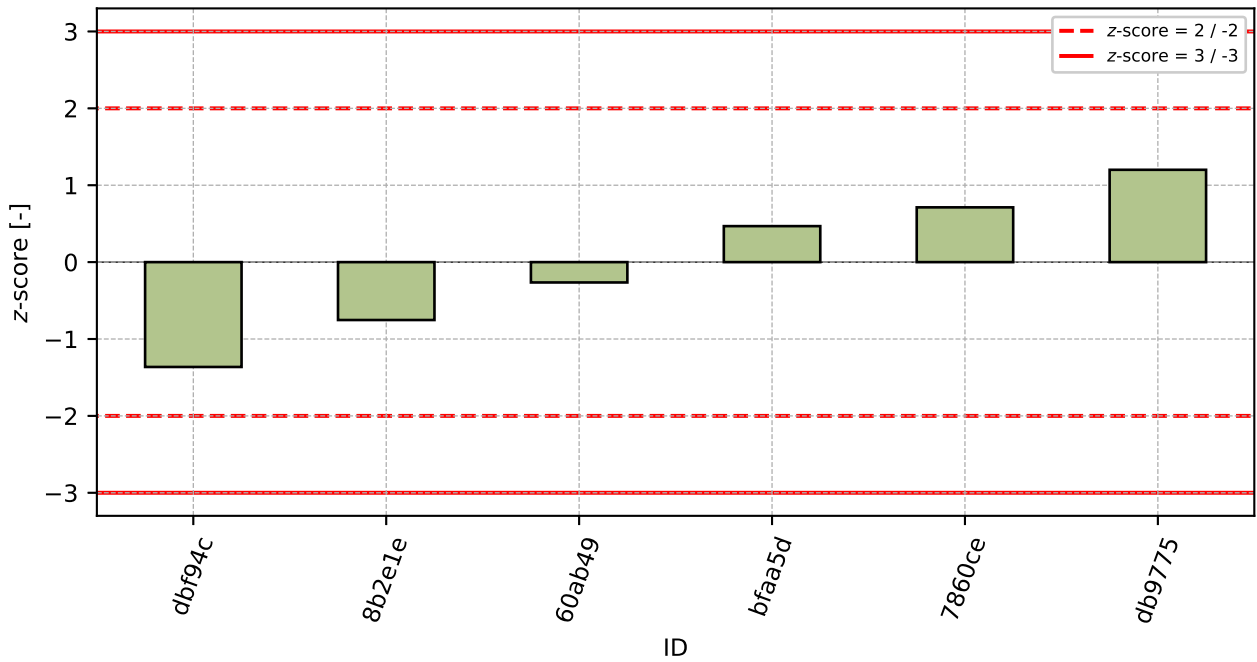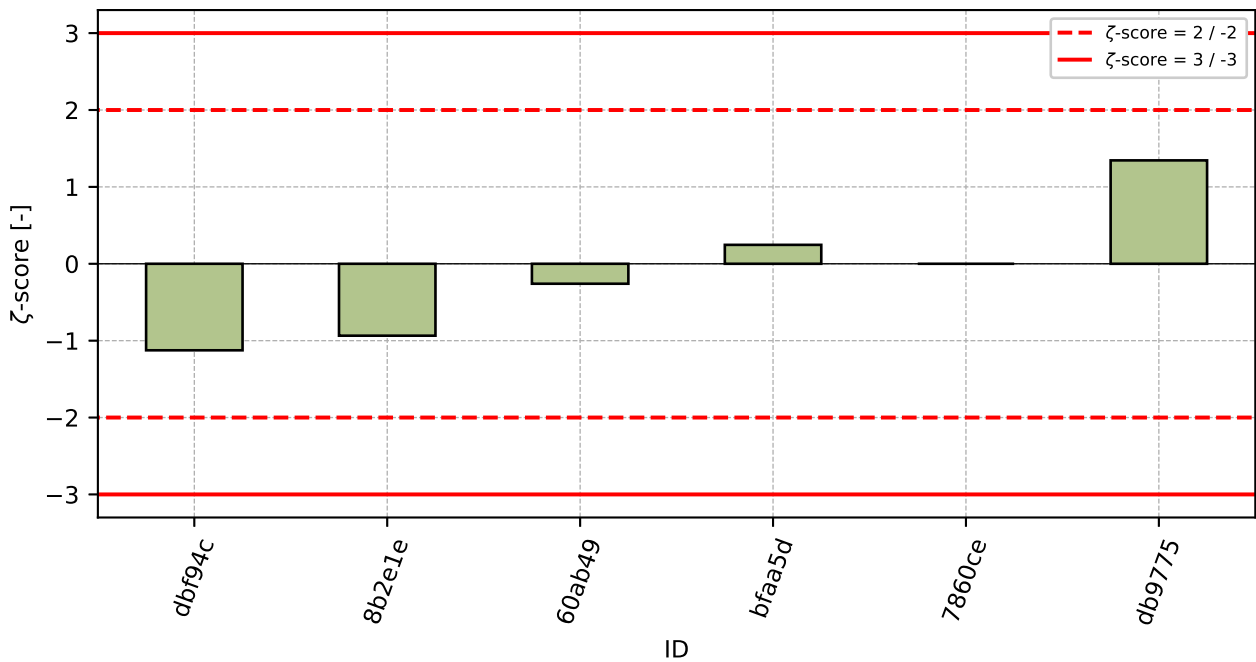
Figure 48: ζ-score

Table 18: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
dbf94c	-1.36	-1.13
8b2e1e	-0.75	-0.94
60ab49	-0.26	-0.26
bfaa5d	0.47	0.25
7860ce	0.71	-
db9775	1.2	1.34

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

10.1   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 [MPa]					u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
bfaa5d	2.17	1.08	1.46	1.27	2.1	0.62	1.62	0.493	30.51
8dd9e4	1.7	1.5	2.5	3.0	2.7	0.5	2.28	0.65	28.49
3745af	2.8	1.74	2.93	3.33	2.81	0.01	2.72	0.59	21.66
fb0fad	2.94	2.99	2.69	2.76	2.64	-	2.8	0.154	5.49
db9775	2.5	2.9	3.0	3.0	2.8	0.4	2.84	0.207	7.3
0a458f	3.02	2.65	3.06	2.86	2.67	0.2	2.85	0.191	6.69
60ab49	2.76	2.84	3.22	3.44	2.8	0.24	3.01	0.302	10.02
96c8ad	2.9	3.3	3.1	3.2	2.7	0.5	3.04	0.241	7.92
d00715	3.15	3.08	3.02	3.53	3.06	0.07	3.17	0.208	6.56
7860ce	2.4	3.4	3.0	3.4	3.8	-	3.2	0.529	16.54
dbf94c	2.65	3.41	3.26	3.11	3.57	0.47	3.2	0.352	11.0
8787bd	3.13	3.2	3.02	-	3.59	3.29	3.24	0.248	7.67
75333c	3.2	3.3	3.6	3.5	3.6	0.6	3.44	0.182	5.28
5828b0	3.4	3.5	3.6	3.6	3.2	0.5	3.46	0.167	4.84
33dab4	3.15	3.62	3.41	3.35	3.89	0.1	3.48	0.282	8.1

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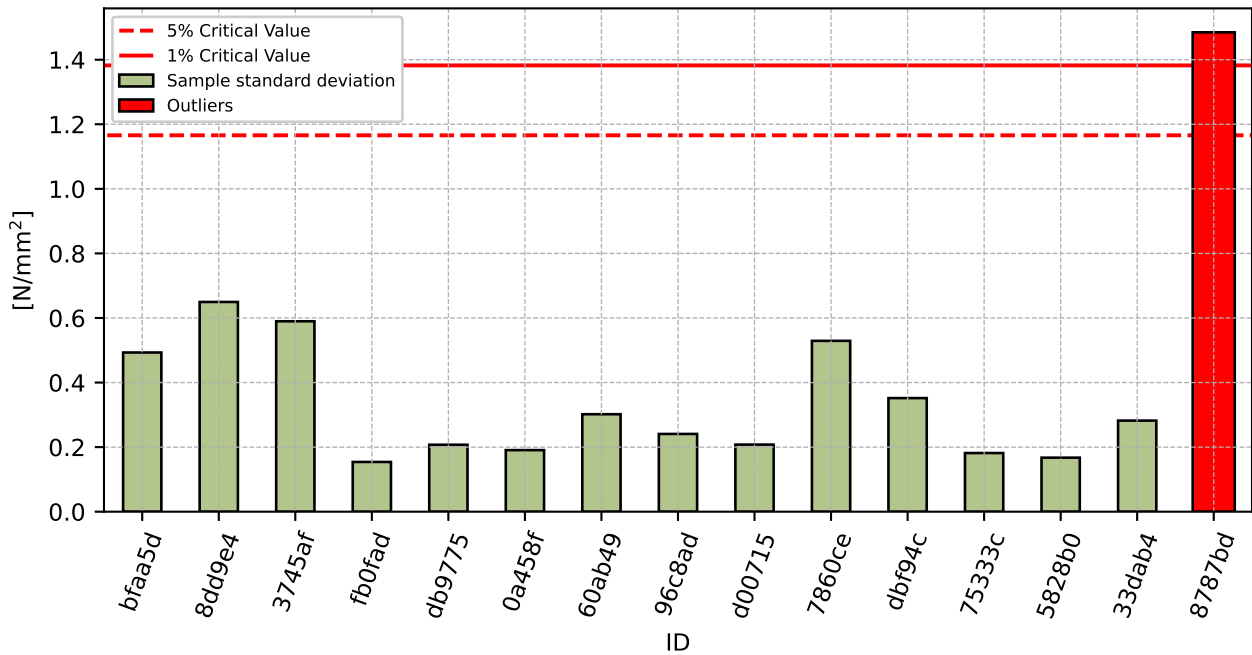## 10.2   The Numerical Procedure for Determining Outliers

Figure 49: **Cochran's test** - sample standard deviations
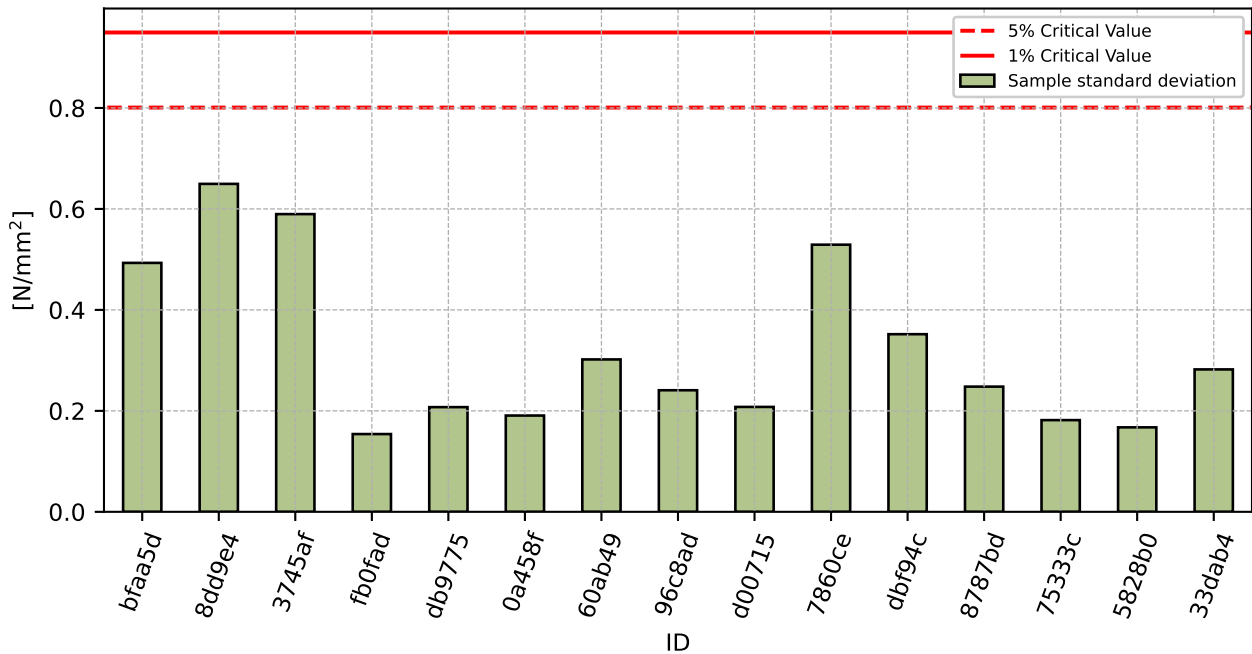
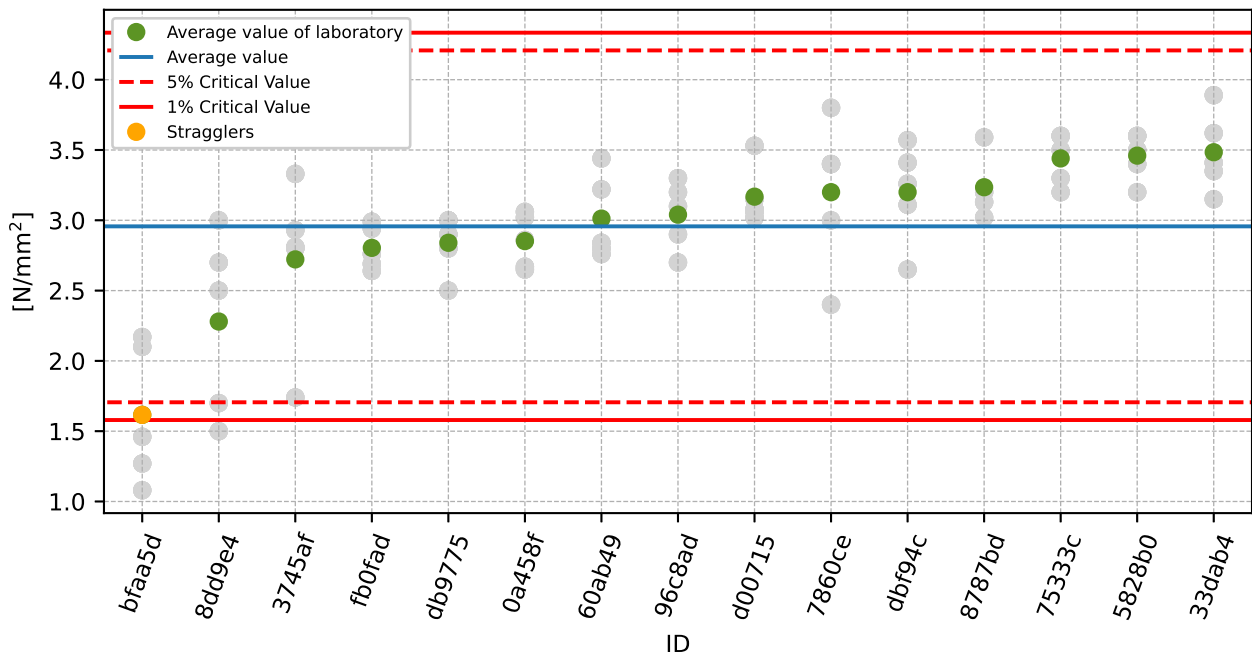Figure 50: **Cochran's test** - sample standard deviations without outliers

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Figure 51: **Grubbs' test** - average values

10.3   Mandel's Statistics
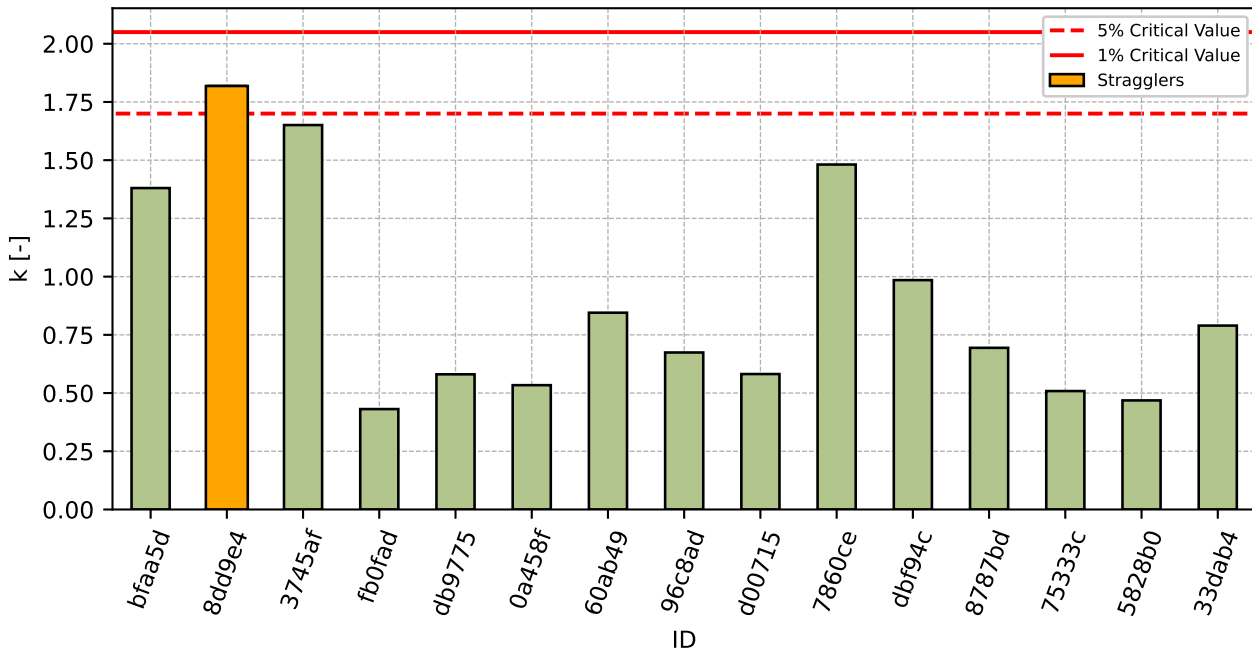
Figure 52: Intralaboratory Consistency Statistic

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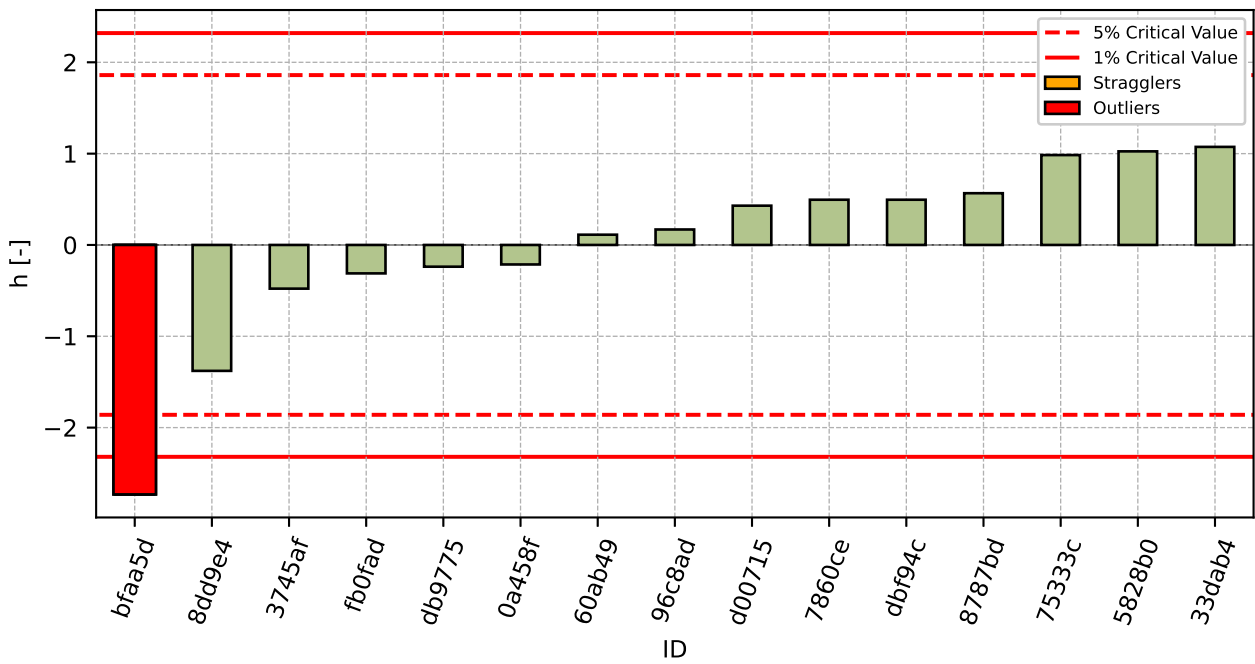
Figure 53: Interlaboratory Consistency Statistic

10.4 Descriptive statistics
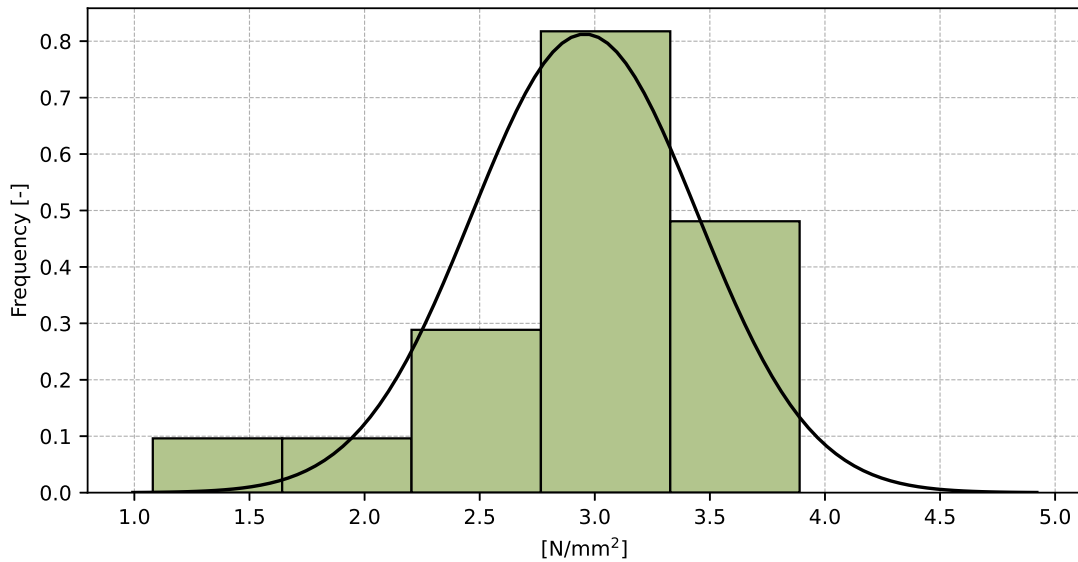
Figure 54: Histogram of all test results

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Table 20: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	2.96
Sample standard deviation – s	0.491
Asigned value – x^*	3.04
Robust standard deviation – s^*	0.33
Measurement uncertainty of asigned value – u_X	0.106
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	0.464
Repeatability standard deviation – s_r	0.357
Reproducibility standard deviation – s_R	0.586
Repeatability – r	1.0
Reproducibility – R	1.64

10.5   Evaluation of Performance Statistics
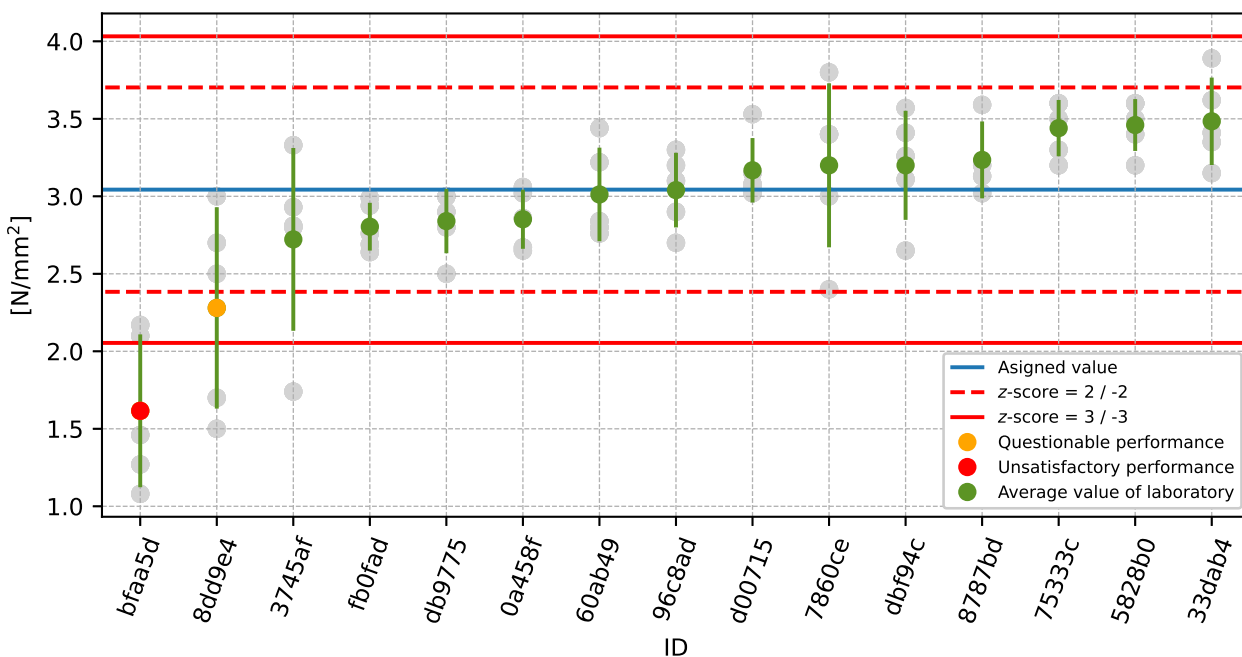
Figure 55: Average values and sample standard deviations

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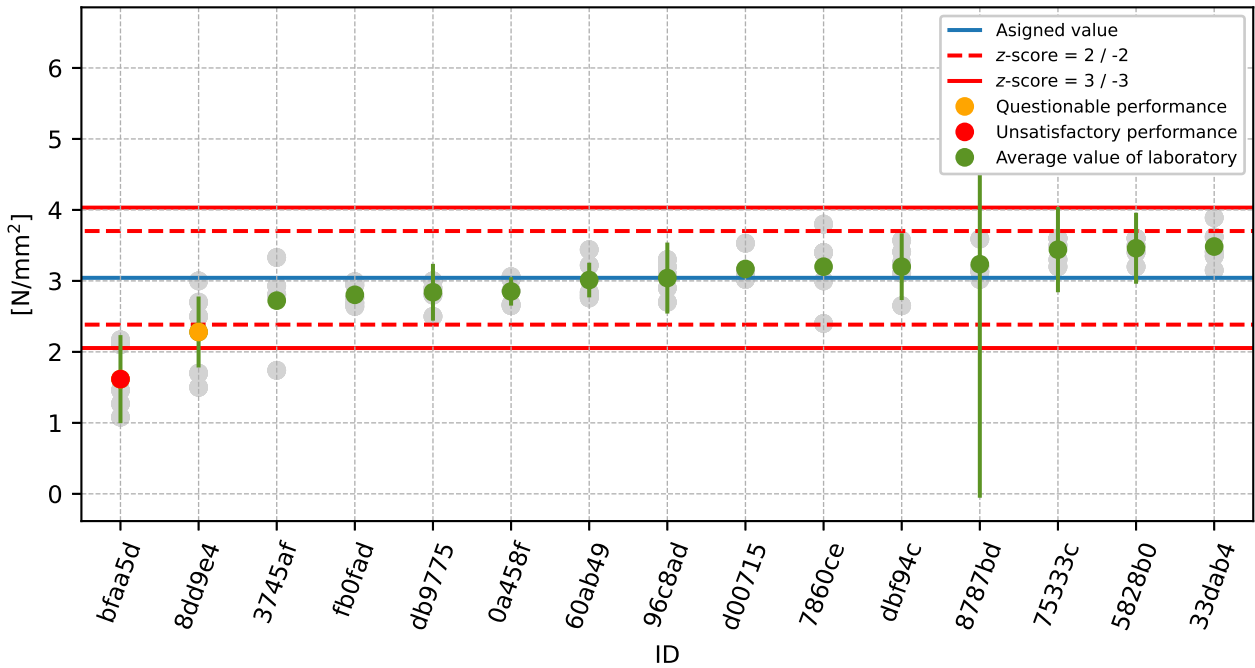
Figure 56: Average values and extended uncertainties of measurement

Figure 57: z-score

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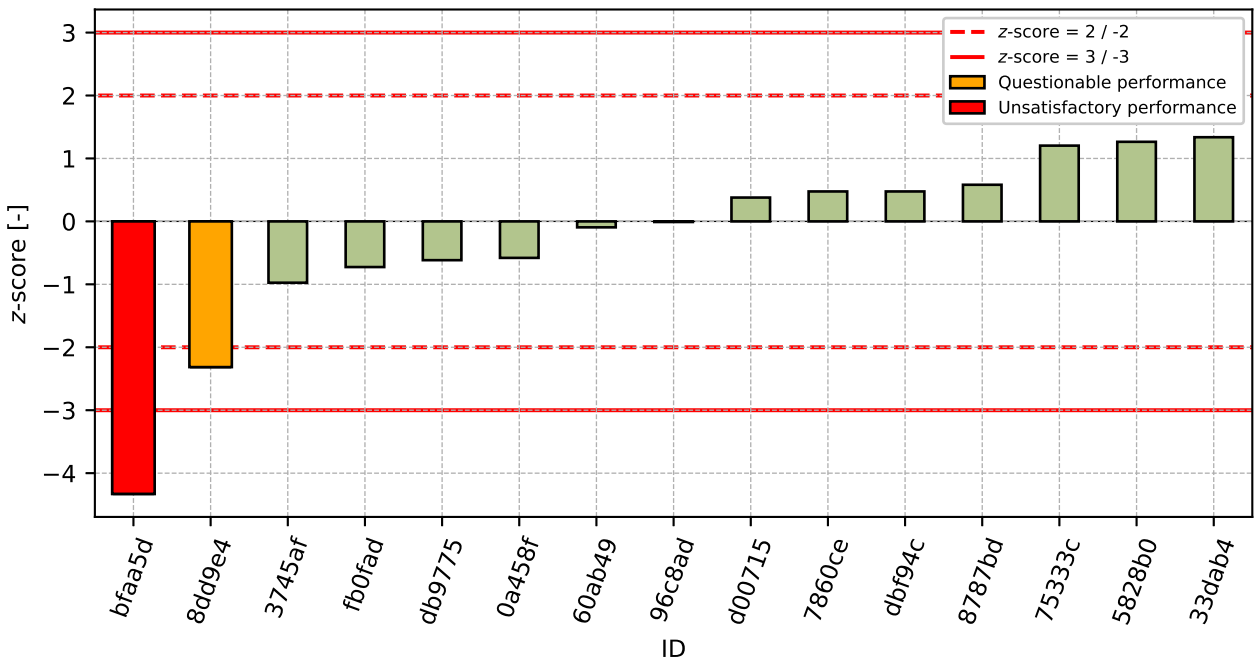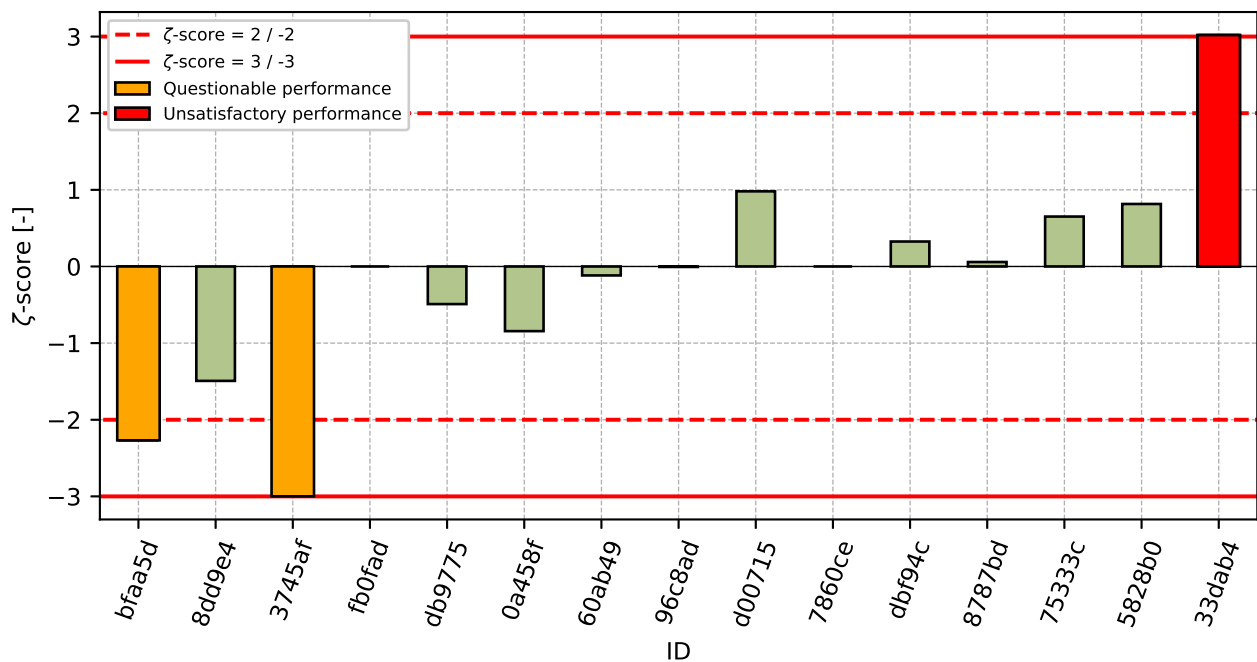
Figure 58: ζ-score

Table 21: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
bfaa5d	-4.33	-2.27
8dd9e4	-2.31	-1.49
3745af	-0.97	-3.0
fb0fad	-0.73	-
db9775	-0.62	-0.49
0a458f	-0.58	-0.84
60ab49	-0.09	-0.12
96c8ad	-0.01	-0.01
d00715	0.38	0.98
7860ce	0.48	-
dbf94c	0.48	0.33
8787bd	0.58	0.06
75333c	1.2	0.65
5828b0	1.26	0.82
33dab4	1.34	3.02

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

11.1   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 [%]
75b47e	3.3	3.3	3.2	-	3.3	0.06	1.77
0a458f	3.4	3.6	3.4	0.3	3.5	0.13	3.6
4b9a6e	3.5	3.9	3.8	0.2	3.7	0.21	5.58
5828b0	4.1	3.5	3.8	0.2	3.8	0.3	7.89
db9775	3.6	3.9	4.1	0.2	3.9	0.25	6.51
8dd9e4	3.8	4.0	3.8	0.2	3.9	0.12	2.99

11.2   The Numerical Procedure for Determining Outliers

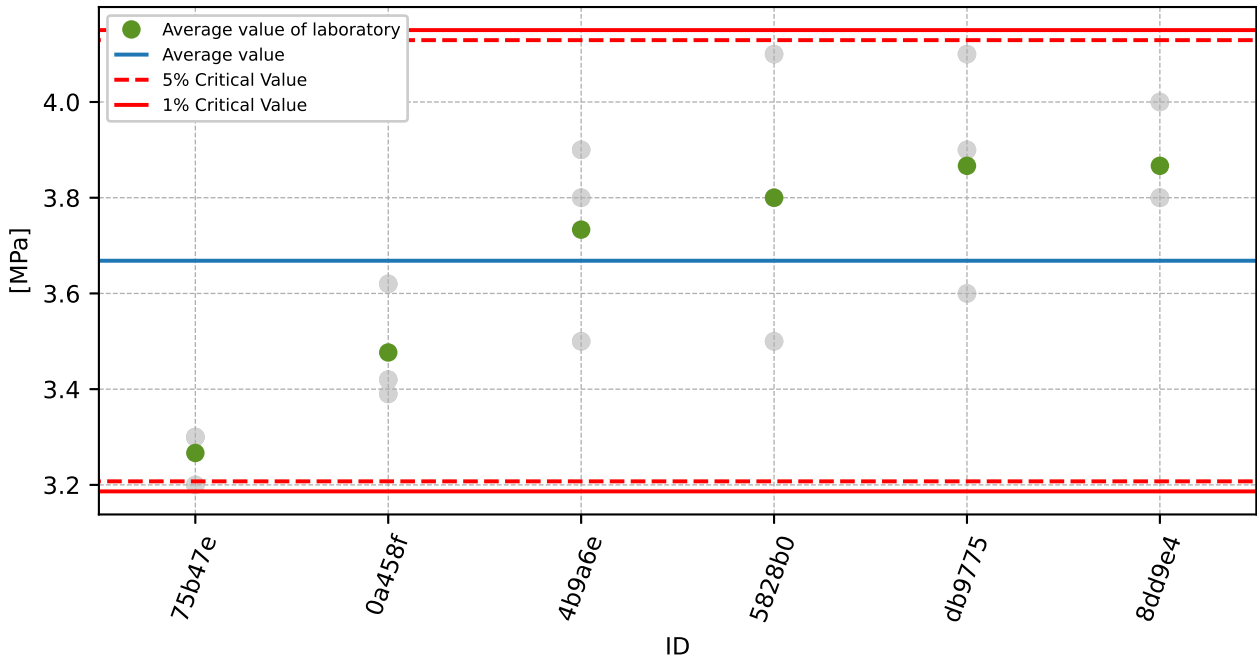Figure 59: **Cochran's test** - sample standard deviations

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Figure 60: **Grubbs' test** - average values

11.3   Mandel's Statistics
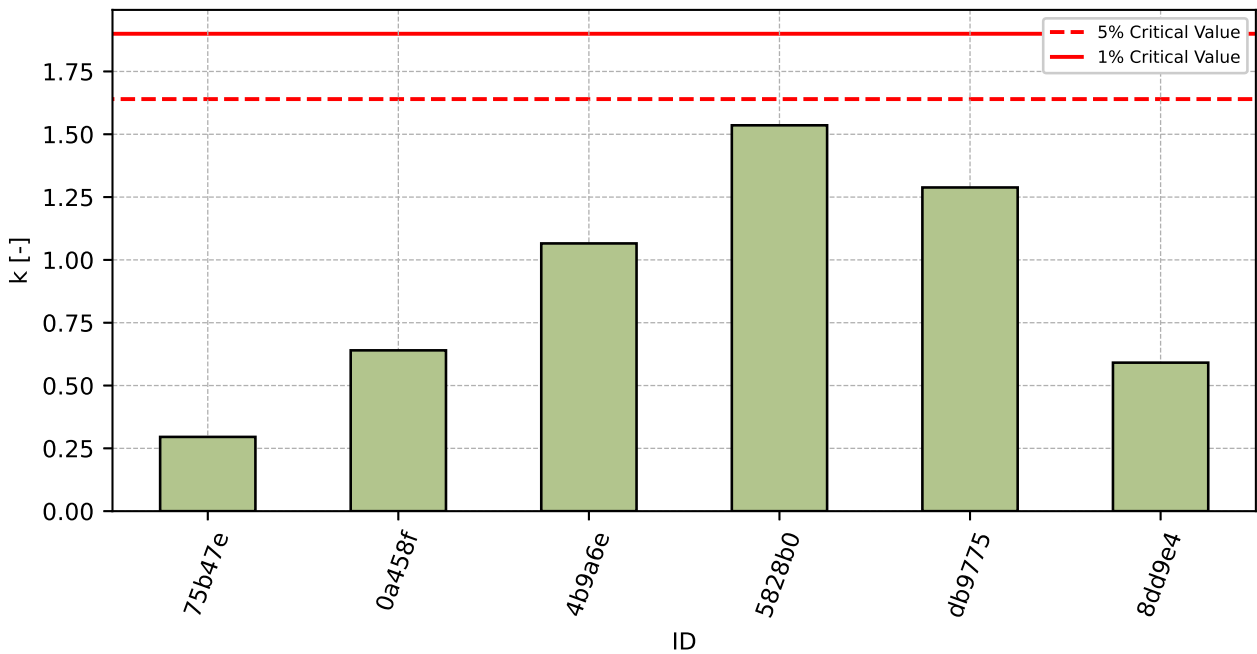
Figure 61: Intralaboratory Consistency Statistic

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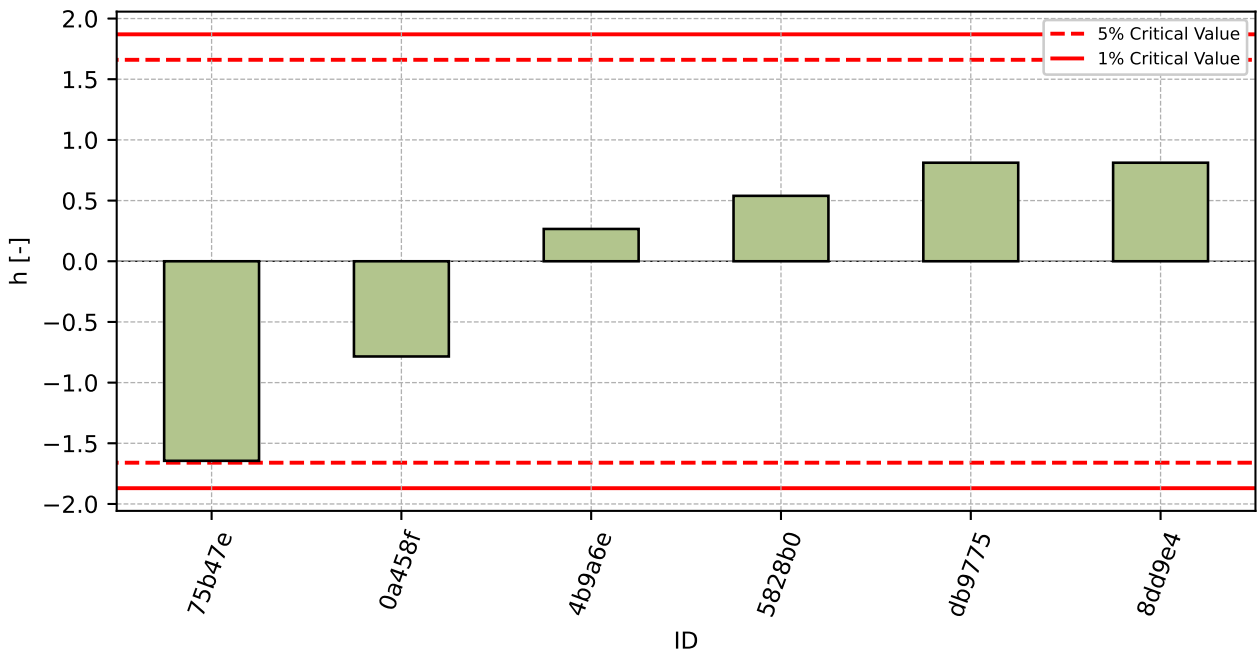
Figure 62: Interlaboratory Consistency Statistic

11.4   Descriptive statistics
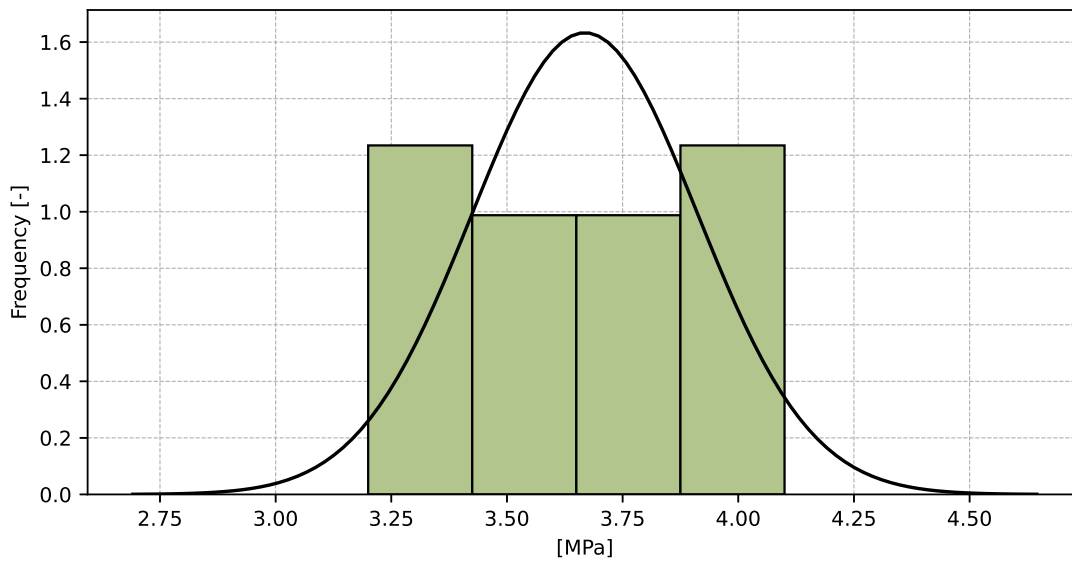
Figure 63: Histogram of all test results

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Table 23: Descriptive statistics

Characteristics	[%]
Average value – $\bar{x}$	3.7
Sample standard deviation – s	0.24
Asigned value – x^*	3.7
Robust standard deviation – s^*	0.24
Measurement uncertainty of asigned value – u_X	0.1
p-value of normality test	0.384 [-]
Interlaboratory standard deviation – s_L	0.22
Repeatability standard deviation – s_r	0.2
Reproducibility standard deviation – s_R	0.29
Repeatability – r	0.5
Reproducibility – R	0.8

11.5 Evaluation of Performance Statistics
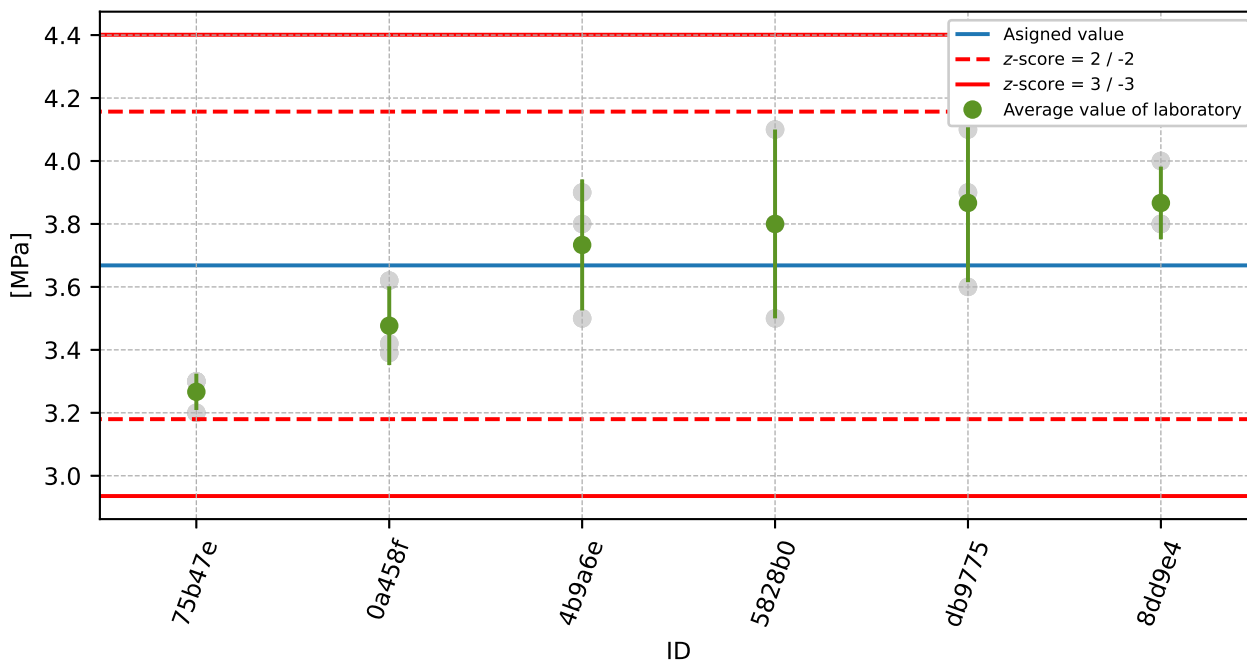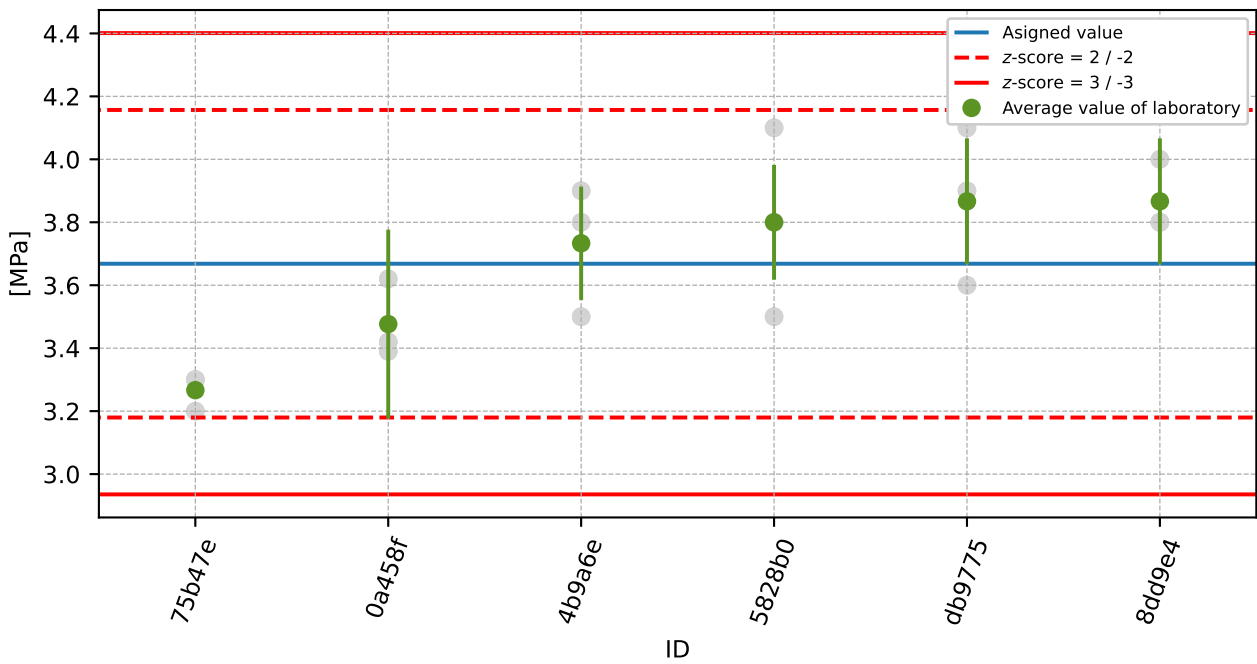

Figure 64: Average values and sample standard deviations

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Figure 65: Average values and extended uncertainties of measurement

Figure 66: z-score

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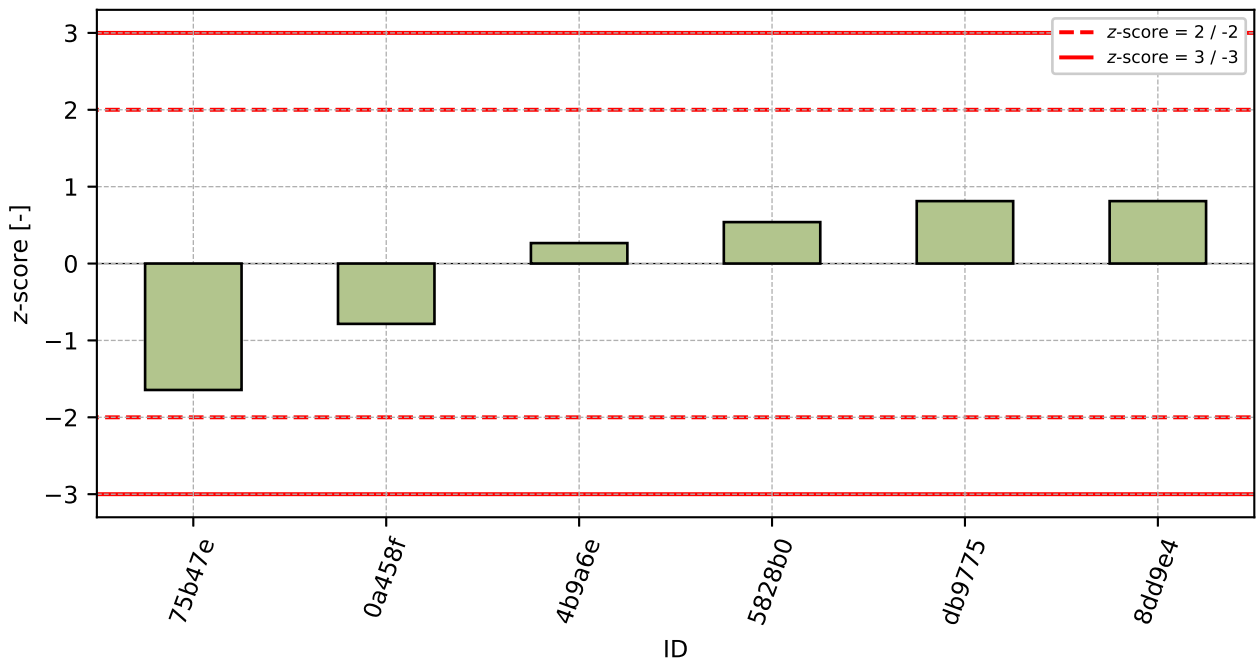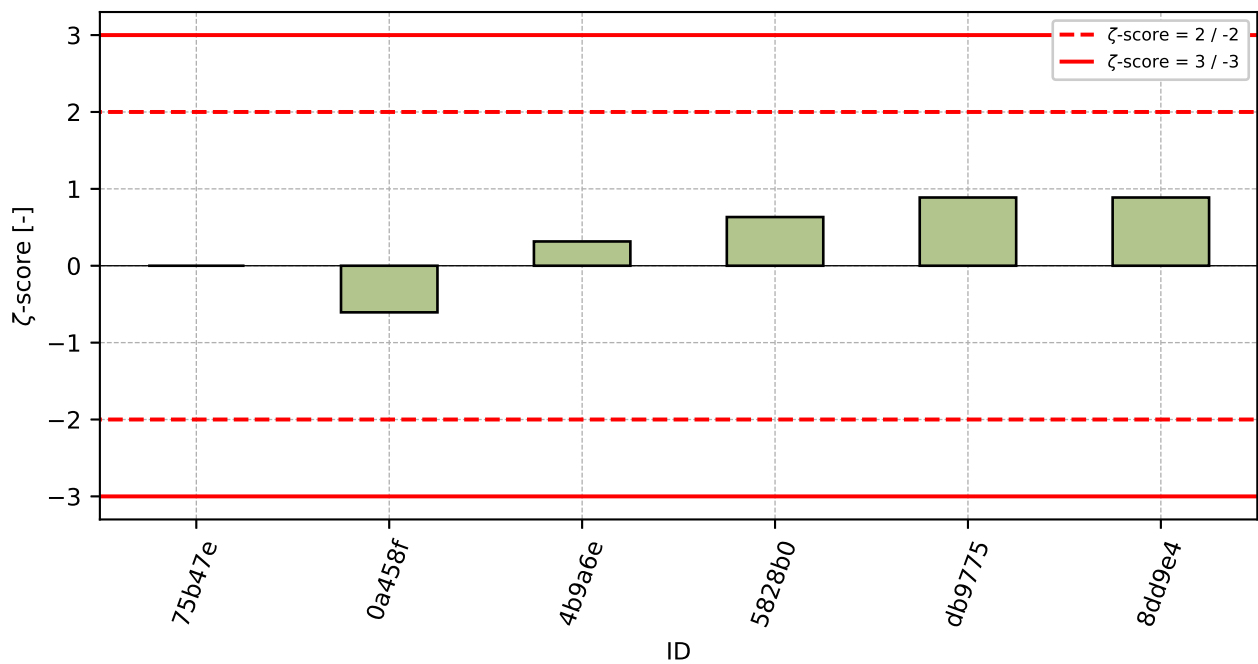
Figure 67: ζ-score

Table 24: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
75b47e	-1.64	-
0a458f	-0.78	-0.61
4b9a6e	0.27	0.32
5828b0	0.54	0.63
db9775	0.81	0.89
8dd9e4	0.81	0.89

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

12.1   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 [MPa]								u_X [MPa]	$\bar{x}$ [MPa]	s_0 [MPa]	V_X [%]
d0f586	5.4	6.2	6.1	5.7	5.6	4.8	4.9	5.3	0.3	5.5	0.51	9.22
0a458f	6.4	5.8	6.3	6.0	4.9	5.0	4.9	5.0	0.5	5.5	0.66	11.88
a21c3b	5.0	5.6	6.1	7.1	6.5	6.2	6.6	5.7	0.6	6.1	0.66	10.8
db9775	5.6	6.7	6.7	7.4	6.1	7.0	6.5	6.9	0.5	6.6	0.56	8.42
96c8ad	7.2	7.2	6.1	7.2	6.7	7.0	6.3	5.9	0.5	6.7	0.53	7.98
4b9a6e	6.6	6.4	7.0	7.2	-	-	-	-	0.1	6.8	0.37	5.37

12.2   The Numerical Procedure for Determining Outliers
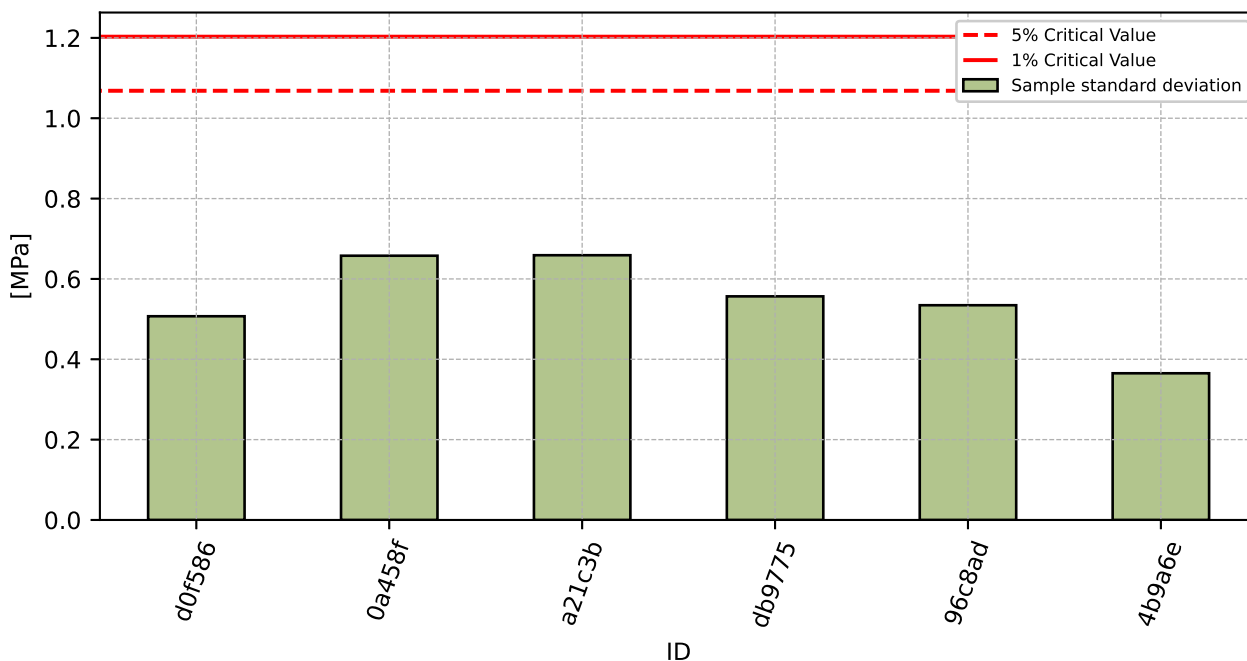
Figure 68: **Cochran's test** - sample standard deviations

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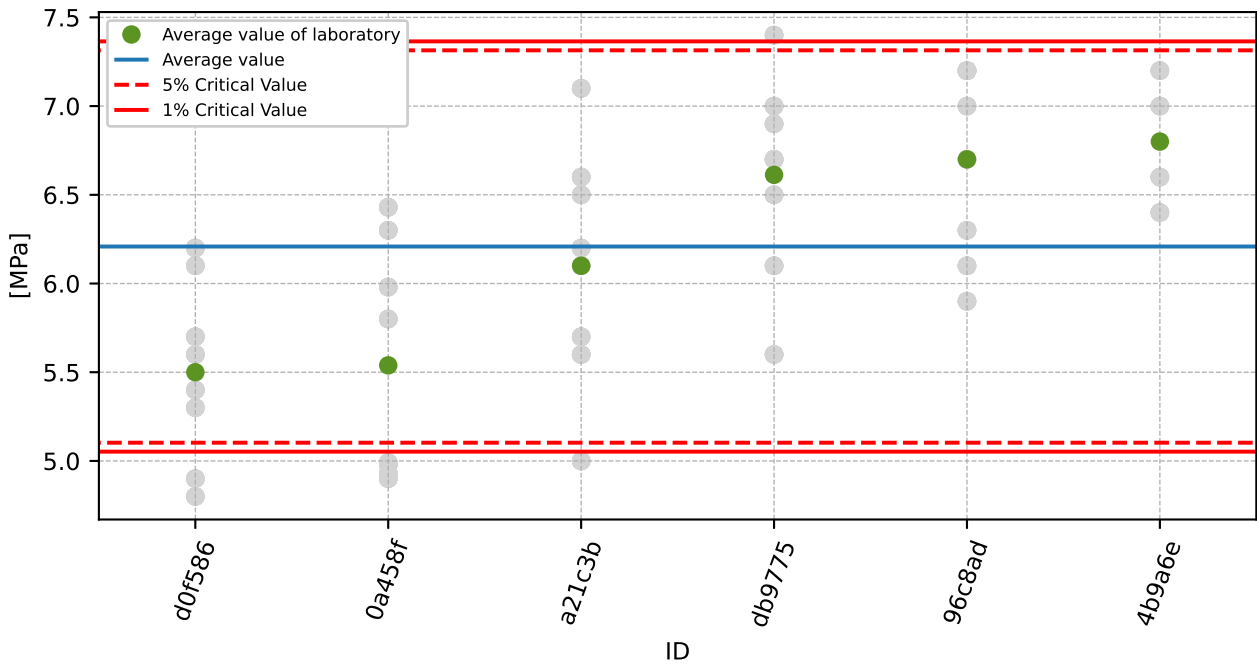szk.fce.vutbr.cz | ptprovider.cz

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

12.3   Mandel's Statistics
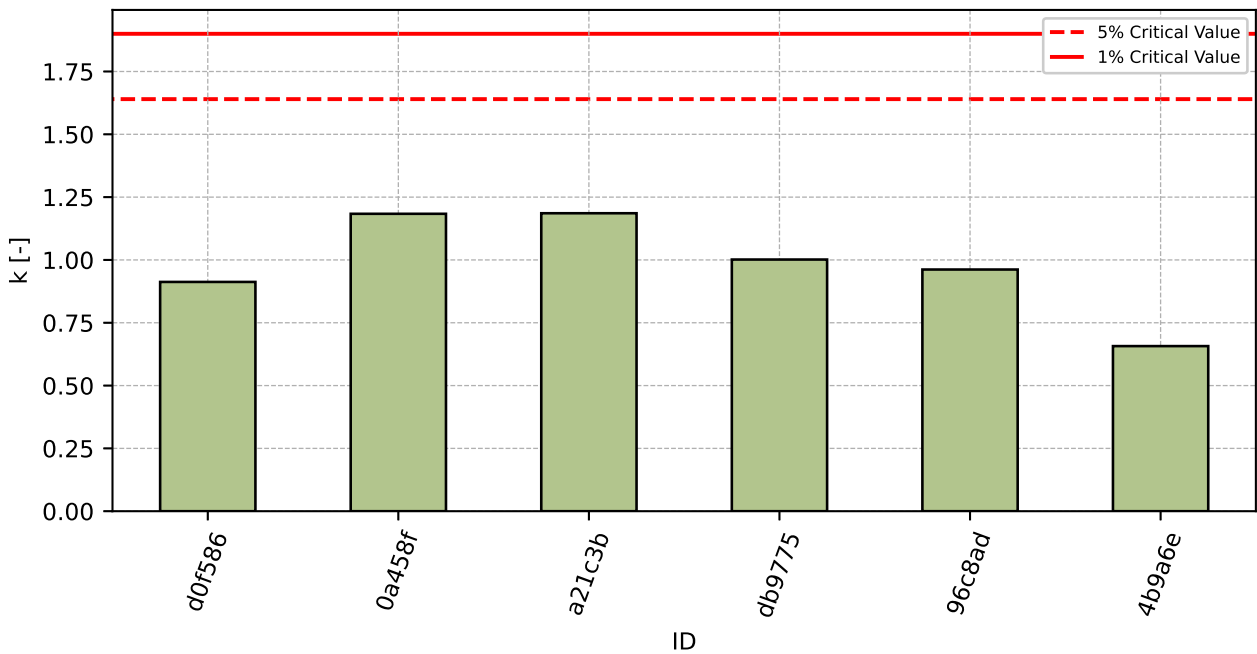
Figure 70: Intralaboratory Consistency Statistic

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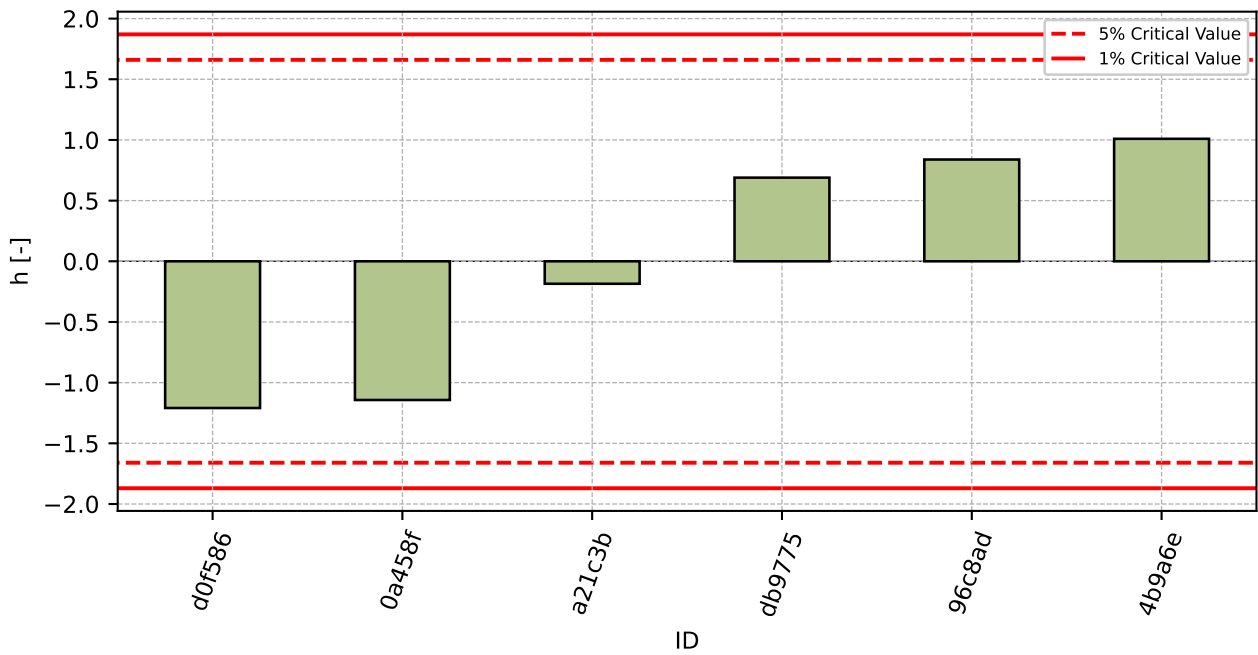
Figure 71: Interlaboratory Consistency Statistic

12.4   Descriptive statistics
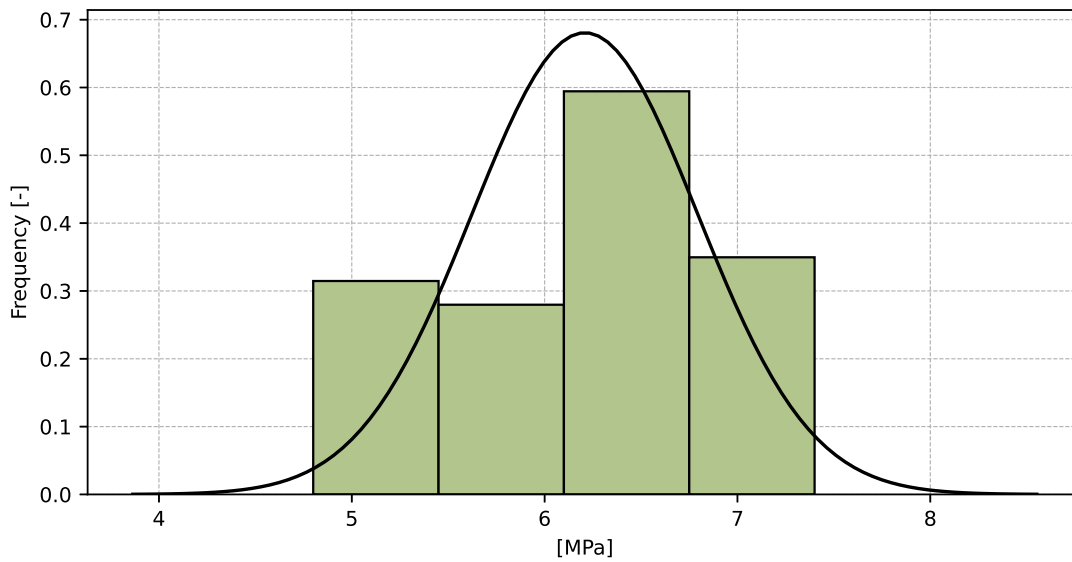
Figure 72: Histogram of all test results

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Table 26: Descriptive statistics

Characteristics	[MPa]
Average value – $\bar{x}$	6.2
Sample standard deviation – s	0.59
Asigned value – x^*	6.2
Robust standard deviation – s^*	0.61
Measurement uncertainty of asigned value – u_X	0.31
p-value of normality test	1.0 [-]
Interlaboratory standard deviation – s_L	0.22
Repeatability standard deviation – s_r	0.2
Reproducibility standard deviation – s_R	0.29
Repeatability – r	0.5
Reproducibility – R	0.8

12.5　Evaluation of Performance Statistics
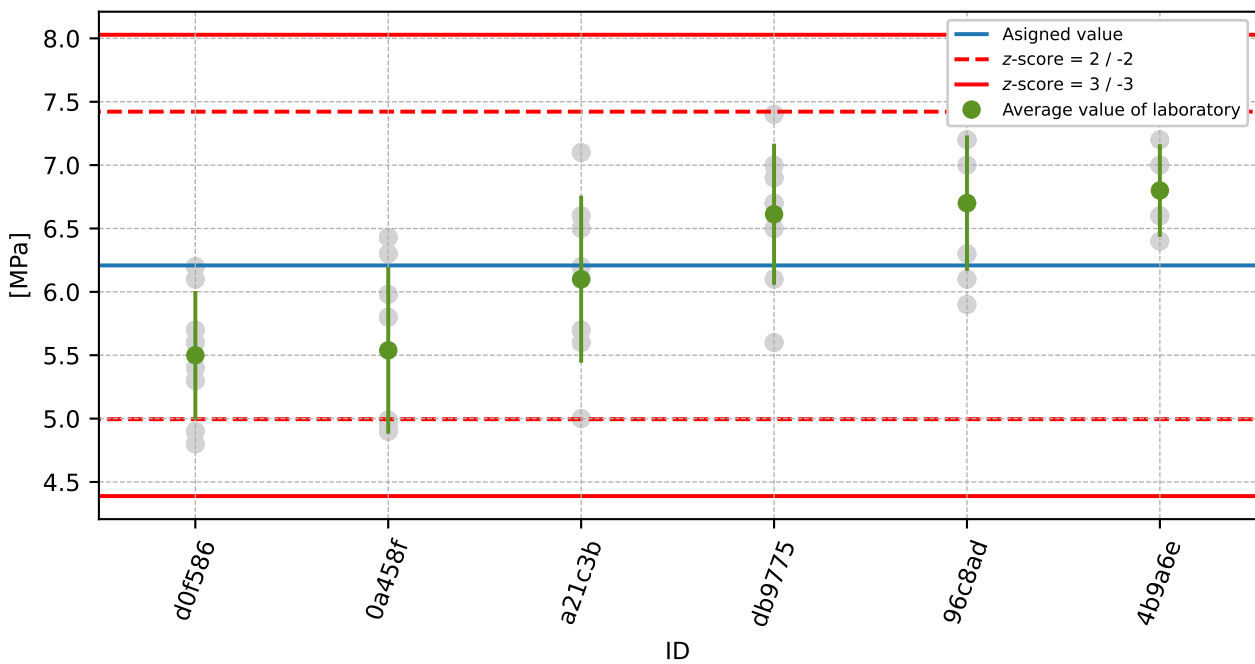
Figure 73: Average values and sample standard deviations

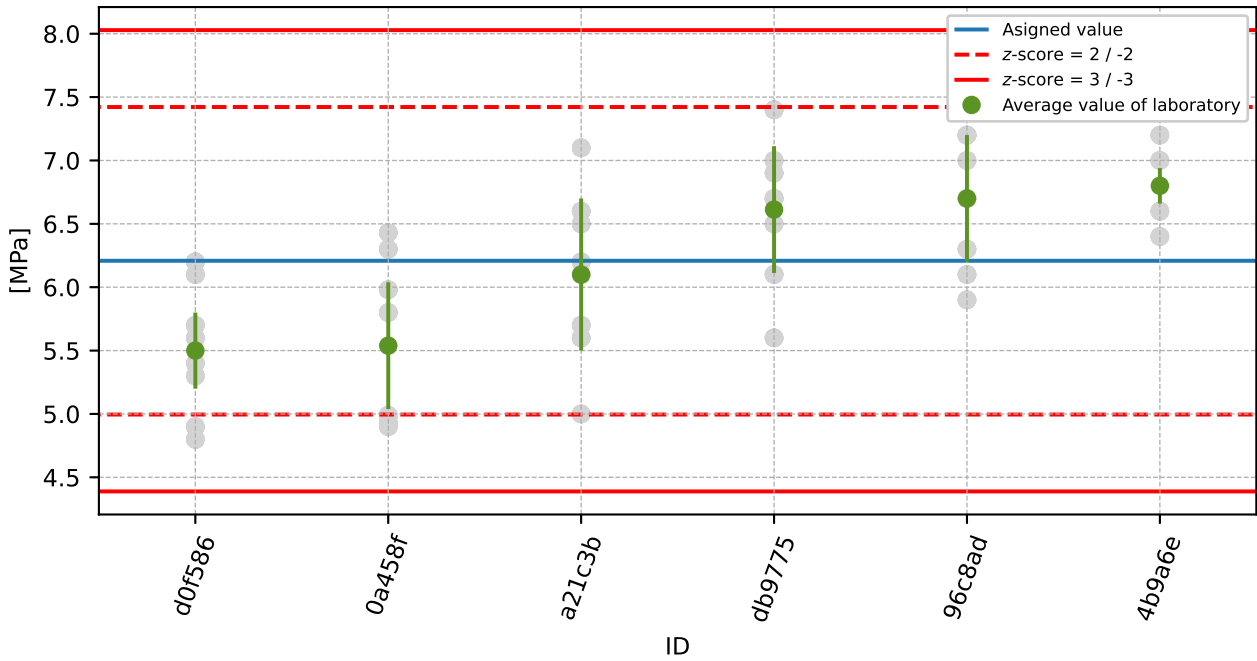Proficiency Testing Provider at the SZK FAST | Z 7008　　　　　　　　　　　　　　62/65
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Figure 74: Average values and extended uncertainties of measurement

Figure 75: z-score

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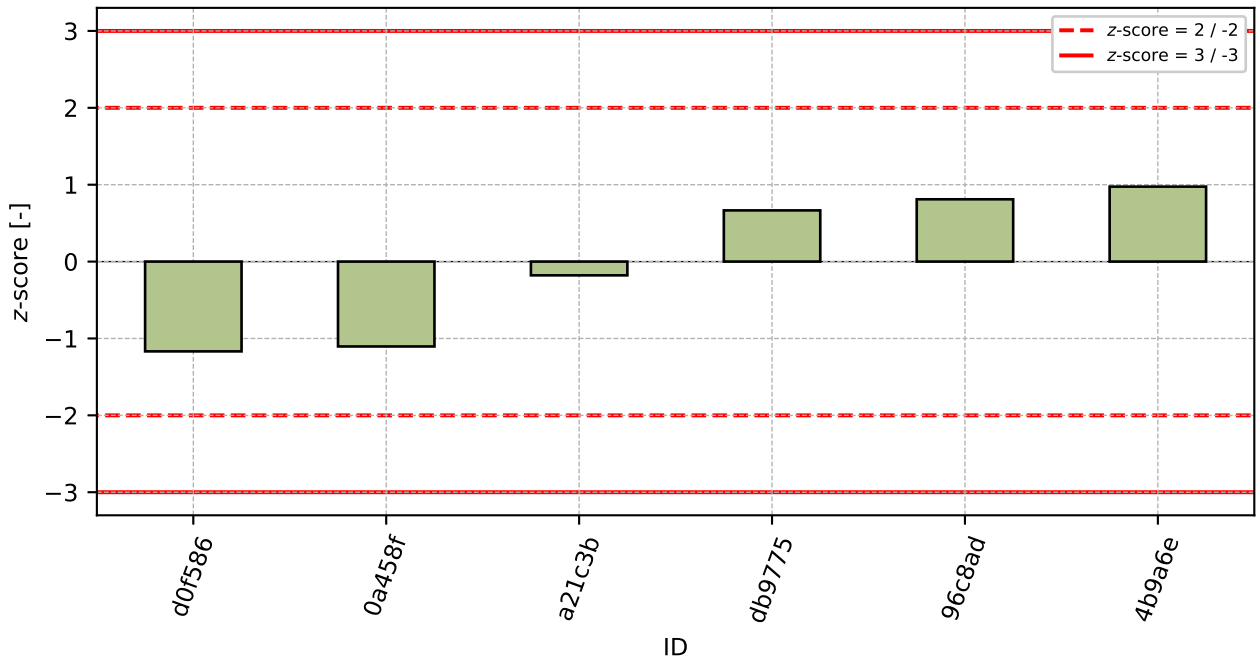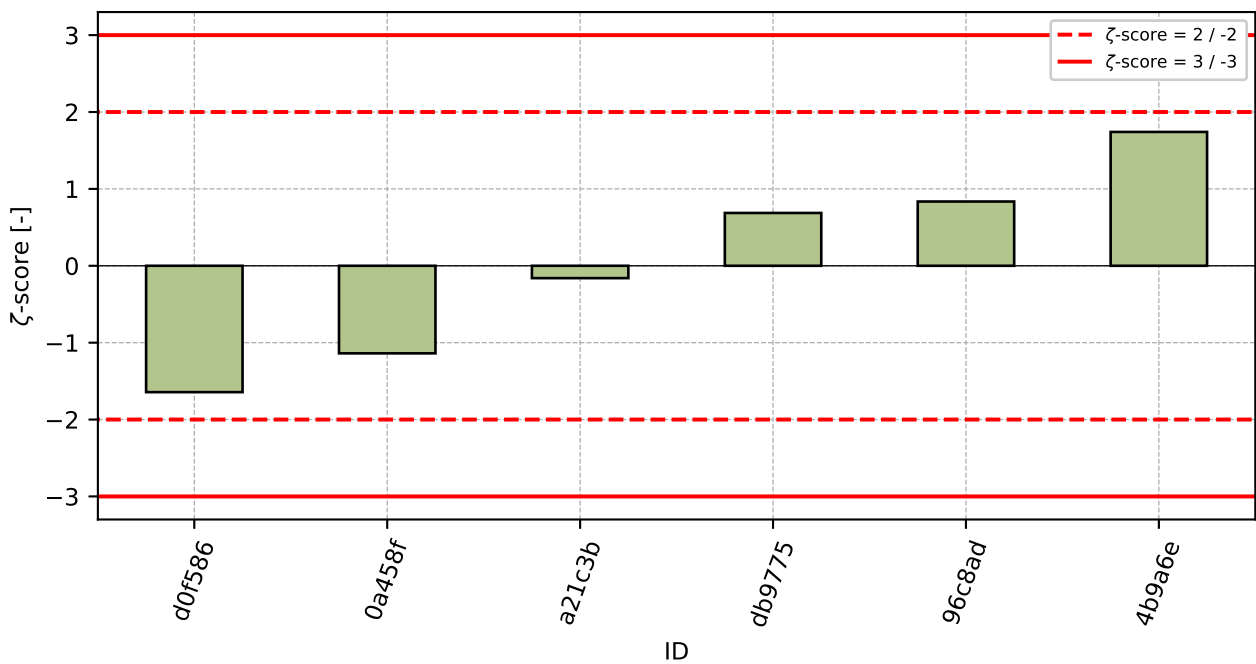
Figure 76: ζ-score

Table 27: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d0f586	-1.17	-1.64
0a458f	-1.1	-1.14
a21c3b	-0.18	-0.16
db9775	0.67	0.69
96c8ad	0.81	0.84
4b9a6e	0.98	1.74

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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 1338 – Appendix F (Flexural strength and flexural load)

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

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