FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

PROFICIENCY TESTING PROGRAM
Soil Testing

ZZ 2018/1

Brno University of Technology
Proficiency testing provider at the SZK FAST
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Date: 01/04/2019

Assoc. Prof. Ing. Tomáš Vymazal, Ph.D.
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 2018, the Proficiency Testing Provider at the SZK FAST (PT Provider) initiated the Proficiency Testing Program (PTP) designated ZZ 2018/1 whose aim was to verify and assess the conformity of test results across laboratories when testing soils.

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	Coordinator of PTP result assessment PrZZ
doc. Ing. Tomáš Vymazal, Ph.D.	**Ing. Petr Misák, Ph.D**.
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The subjects of proficiency testing were the following testing procedures:

1. EN ISO 17892-1 Geotechnical investigation and testing - Laboratory testing of soil - Part 1: Determination of water content [1],

2. EN ISO 17892-3 Geotechnical investigation and testing - Laboratory testing of soil - Part 3: Determination of particle density [2],

3. EN ISO 17892-4 Geotechnical investigation and testing - Laboratory testing of soil - Part 4: Determination of particle size distribution [3],

4. EN ISO 17892-5 Geotechnical investigation and testing - Laboratory testing of soil - Part 5: Incremental loading oedometer test [4],

5. EN ISO 17892-7 Geotechnical investigation and testing - Laboratory testing of soil - Part 7: Unconfined compression test [5],

6. CEN ISO/TS 17892-10 Geotechnical investigation and testing - Laboratory testing of soil - Part 10: Direct shear tests [6],

7. EN ISO 17892-12 Geotechnical investigation and testing - Laboratory testing of soil - Part 12: Determination of liquid and plastic limits [7],

8. EN 13286-2 Unbound and hydraulically bound mixtures - Part 2: Test methods for laboratory reference density and water content -Proctor compaction [8],

9. EN 13286-47 Unbound and hydraulically bound mixtures - Part 47: Test method for the determination of California Bearing ratio, immediate bearing index and linear swelling [9].

Testing procedures No 4 – 6 were not open due to the low number of participants.

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 [10] and with EN ISO/IEC 17043 [11]. The outcome is the present final report summarizing the results of the interlaboratory comparison, including statistical evaluation.

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

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

ID/Testing Method	1	2	3	4	5	6	7	8	9
042826	-	X	X	-	-	-	-	-	-
3490e6	X	X	X	-	-	-	X	X	X
0149da	X	X	X	-	-	-	X	X	-
06ca53	-	-	-	-	-	-	-	X	X
20d0e7	-	X	-	-	-	-	-	-	-
20fbb6	X	-	X	-	-	-	X	-	-
381a49	X	X	X	-	-	-	X	X	-
387c59	-	-	-	-	-	-	X	-	-
39a58b	X	X	X	-	-	-	X	X	X
45b885	-	-	-	-	-	-	X	-	-
45cad1	-	-	-	-	-	-	X	X	X
50e96f	X	X	X	-	-	-	X	X	X
5dc8ae	X	-	-	-	-	-	-	X	-
6ad9ef	-	-	-	-	-	-	-	-	X
7b64ea	-	X	-	-	-	-	-	-	-
832a77	X	X	X	-	-	-	X	X	X
8b6464	X	X	X	-	-	-	X	X	-
8d0790	-	-	-	-	-	-	-	-	X
919bbf	-	-	-	-	-	-	-	-	X
a3887b	X	-	X	-	-	-	-	-	-
a53b17	-	-	-	-	-	-	-	X	-
a75426	-	-	X	-	-	-	-	-	-
ac5ed6	-	-	X	-	-	-	X	-	-
b3a991	-	-	-	-	-	-	X	-	X
becf4a	-	-	-	-	-	-	-	-	X
c75b1d	-	-	-	-	-	-	-	X	-
ce9f4e	X	-	-	-	-	-	X	-	-
d3aa20	-	-	-	-	-	-	-	-	X
d6e1e1	-	-	-	-	-	-	X	X	-
da116f	-	X	X	-	-	-	X	-	-
ec1502	-	-	-	-	-	-	-	-	X
f9c800	X	-	-	-	-	-	-	-	-

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

Laboratory	Address	Accreditation number
B-PROJEKTY Teplice s.r.o.	Kollárova 1879/11, Teplice, 415 01, Česká republika	1428
Centrum dopravního výzkumu, v.v.i.	Líšeňská 33a, Brno, 63600, Česká republika	1506
ENERGOPROJEKT NISKOGRADNJA AD BEOGRAD	Boulevard Mihaila Pupina 12, New Belgrade, 11070, Republic of Serbia	-
EUROVIA Services s.r.o., pracoviště České Budějovice	Národní 138/10, PRAHA 1, 110 00, Česká republika	1424
EUROVIA Services s.r.o., pracoviště Letkov	Národní 138/10, PRAHA 1, 110 00, Česká republika	1524

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Laboratory	Address	Accreditation number
EUROVIA Services s.r.o., pracoviště Sedlec	Národní 138/10, Praha 1, 110 00, Česká republika	1524
Eurovia Services, s.r.o., Centrální laboratoř, pracoviště Cl1	Národní 138/10, Praha 1, 110 00, Česká republika	1112
Eurovia Services, s.r.o., Centrální laboratoř, pracoviště Cl4	Národní 138/10, Praha 1, 110 00, Česká republika	1112
GEODRILL s.r.o.	K Bukovinám 169/45, Brno, 63500, Česká republika	1596
GEOtest, a.s.	Šmahova 112, Brno, 627 00, Česká republika	1271.2
GIM-TEST d.o.o. Banja Luka	Palih boraca 55, lokal br. 2, Banja Luka, 78000, Bosnia and Herzegovi	-
INSTITUT 1. MAJ d.o.o. NIŠ	Kneginje Ljubice 1/II, Niš, 18000, Serbia	01-288
Institute IMS, Laboratory for Roads and Geotechnics	Bulevar vojvode Misica 43, Belgrade, 11000, Serbia	ATS 01-138
Ivica Ivandić	Dobropoljska 21, Beograd, 11000, Serbia	-
KOLEJCONSULT & servis, spol. s r.o.	Křenová 131/35, Brno, 602 00, Česká republika	1305
LABORATORUL DE ANALIZE SI INCERCARI IN CONSTRUCTII	Str. Sîngerului, nr. 11, sector 1,, Bucharest, 014617, Romania	-
LI "Zemna mehanika" - Baugrund Institut Knirim OOD	3 Tsarevo selo Str., atelie-parter, Sofia, 1612, Bulgaria	255LI
Mining and Metallurgy Institute Bor	Zeleni bulevar 35, Bor, 19210, Serbia	01-308, ATS Serbia
NIEVELT Labor CZ s.r.o.	Za Olomouckou 4184/17, Prostějov, 79601, Česká republika	1716
QUALIFORM SLOVAKIA s.r.o. - org. složka	Lesní 693, Bílovice nad Svitavou, 66401, Česká republika	-
QUALIFORM, a.s. - pracoviště č. 01	Mlaty 672/8, Brno - Bosonohy, 64200, Česká republika	1008
QUALIFORM, a.s. - pracoviště č.06	Mlaty 672/8, Brno - Bosonohy, 64200, Česká republika	1008
Rudarski institut d.d. Tuzla	Rudarska 72, Tuzla, 75000, Bosna i Hercegovina	LI-47-01
Rudarski institut, Beograd, Srbija (Mining Institute , Belgrade)	Batajnicki put br. 2, Zemun, Beograd, 11080, Serbia	01-309
SQZ, s.r.o. - Ústřední laboratoř Olomouc - pracoviště Olomouc	U místní dráhy 939/5, Olomouc, 779 00, Česká republika	1135.1
TPA ČR, s.r.o.	Vrbenská 1821/31, České Budějovice, 370 06, Česká republika	1181
TPA EOOD CTC SOFIA	Rezbarska 7 str., Sofia, 1510, Bulgaria	-
TPA za obezbeđenje kvaliteta i inovacije d.o.o. Beograd	Milutina Milankovića 3b, Novi Beograd (New Belgrade), 11070, Srbija (Serbia)	01-280
UAB "Sweco Lietuva"	A. Strazdo g. 22, Kaunas, LT-48488, Lithuania	-
Ústav stavebního zkušebnictví s.r.o.	Jiřího Potůčka 115, Pardubice, 53009, Česká republika	1115
Vlaamse Overheid - MOW- afdeling Geotechniek	Technologiepark zone A4 gebouw 905, Zwijnaarde, 9052, Belgium	Belac- 177 Test

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2 Procedures used in the Statistical Analysis of Laboratory Results

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 ZZ 2018/1 (PT Program) organized by the PT Provider at the SZK FAST, Brno University of Technology. 32 participants (laboratories) took part in the PT Program. The program focused on ordinary standarized testing of soil. 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.

   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. The assigned value and its uncertainty were determined according to the procedures stated in the section 2. z-score and ζ-score are compared with limit values (see part 2). 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.

3.1 EN ISO 17892-1 – Water content

The test results are shown together with graphic presentation and evaluated statistical characteristics in part 1 of the Appendix.

   The numerical critical evaluation using Cochran's test has shown that results of participant 381a49 exceeded the 1% critical value. A more detailed analysis has revealed that the outlying variability was caused by one test result only. This test result was removed from the experiment. The 5% critical value was exceeded after Cochran's test recounting. The test results of participant 381a49 were considered to be divergent and were not excluded from the experiment. A numerical critical evaluation using Grubbs' test has not shown any exceedence of critical values.

   Graphical determination of the consistency of laboratories (Mandel's statistics) has shown an exceedence of the critical value in the test results from some participants. The exceedence 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. None of the participants were therefore excluded.

   The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [12]). The limit value z-score $= 2$ was exceeded in the case of participant **381a49**, whose performance was rated as **questionable**. The results of all other participants did not exceed the limit value of z-score $= 2$ and thus can be rated as **satisfactory**.

3.2 EN ISO 17892-3 – Particle density

The test results are shown together with graphic presentation and evaluated statistical characteristics in part 2 of the Appendix.

   The numerical critical evaluation using Cochran's test has shown that results of participant 042826 exceeded the 1% critical value. A more detailed analysis has revealed that the exceedence was caused by the extremely low variability of the observed values of most participants. Also the value of variation coefficient of this participant was very low ($V_X = 1.32$ %), hence the test results of the participant 042826 were not excluded from the experiment. A numerical critical evaluation using Grubbs' test has not shown any exceedence of critical values.

   The Graphical determination of the consistency of laboratories (Mandel's statistics) has shown an exceedence of the critical value in the test results from some participants. The exceedence 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. None of the participants were therefore excluded.

   The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [12]). Based on this analysis the results of all participants did not exceed the limit value of z-score $= 2$ and thus can be rated as **satisfactory**.

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3.3 EN ISO 17892-4 – Particle size distribution

This testing method was evaluated as a multilevel experiment. Each level is formed by sieve size. Statistical characteristics were evaluated for each level separately: 0.063 mm – 8 mm. The test results are shown together with graphic presentation and evaluated statistical characteristics in the Appendix 3. The results were assessed as outlying, questionable and unsatisfactory in case of three appropriate levels at least.

The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [12]). The results of all participants did not exceed the limit value of z-score $= 2$ in case of three appropriate levels at least and thus can be rated as **satisfactory**.

3.4 EN ISO 17892-5 – Incremental loading oedometer test

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

3.5 EN ISO 17892-7 – Unconfined compressive strength, Strain at failure

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

3.6 CEN ISO/TS 17892-10 – Effective shear parameters

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

3.7 EN ISO 17892-12 – Atterberg limits

Two characteristics were measured – liquit limit and plastic limit. These characteristics were evaluated separately.

The test results are shown together with graphic presentation and evaluated statistical characteristics in the Appendix 7. The numerical critical evaluation of the test results using Cochran's and Grubbs' test has not shown any exceedence of critical values. The Graphical determination of the consistency of laboratories (Mandel's statistics) has shown an exceedence of the critical value in the test results from some participants. The exceedence 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. None of the participants were therefore excluded.

The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [12]). Based on this analysis the results of all participants did not exceed the limit value of z-score $= 2$ and thus can be rated as **satisfactory**.

3.8 EN 13286-2 – Proctor

Two characteristics were measured – Proctor density and optimum water content. These characteristics were evaluated separately.

The test results are shown together with graphic presentation and evaluated statistical characteristics in the Appendix 8. The numerical critical evaluation of the test results using Grubbs' test has not shown any exceedence of critical values. The Graphical determination of the consistency of laboratories (Mandel's statistics) has shown an exceedence of the critical value in the test results from some participants. The exceedence 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. None of the participants were therefore excluded.

The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [12]). The limit value z-score $= 3$ was exceeded in the case of participant **381a49**, whose performance was rated as **unsatisfactory**. The limit value z-score $= 2$ was exceeded in the case of participant **06ca53**, whose performance was rated as **questionable**. The results of all other participants did not exceed the limit value of z-score $= 2$ and thus can be rated as **satisfactory**.

3.9 EN 13286-47 – CBR

The test results are shown together with graphic presentation and evaluated statistical characteristics in the Appendix 9. The numerical and graphical critical evaluation did not indicate any exceedence of critical values. None of the participants were therefore excluded.

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The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [12]). The limit value z-score $= 3$ was exceeded in the case of participant **ec1502**, whose performance was rated as **unsatisfactory**. The results of all other participants did not exceed the limit value of z-score $= 2$ and thus can be rated as **satisfactory**.

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References

[1] EN ISO 17892-1. *Geotechnical investigation and testing - Laboratory testing of soil - Part 1: Determination of water content.* 2015.

[2] EN ISO 17892-3. *Geotechnical investigation and testing - Laboratory testing of soil - Part 3: Determination of particle density.* 2016.

[3] EN ISO 17892-4. *Geotechnical investigation and testing - Laboratory testing of soil - Part 4: Determination of particle size distribution.* 2017.

[4] EN ISO 17892-5. *Geotechnical investigation and testing - Laboratory testing of soil - Part 5: Incremental loading oedometer test.* 2017.

[5] EN ISO 17892-7. *Geotechnical investigation and testing - Laboratory testing of soil - Part 7: Unconfined compression test.* 2018.

[6] CEN ISO/TS 17892-10. *Geotechnical investigation and testing - Laboratory testing of soil - Part 10: Direct shear tests.* 2005.

[7] EN ISO 17892-12. *Geotechnical investigation and testing - Laboratory testing of soil - Part 12: Determination of liquid and plastic limits.* 2018.

[8] EN 13286-2. *Unbound and hydraulically bound mixtures - Part 2: Test methods for laboratory reference density and water content - Proctor compaction.* 2011.

[9] EN 13286-47. *Unbound and hydraulically bound mixtures - Part 47: Test method for the determination of California Bearing ratio, immediate bearing index and linear swelling.* 2012.

[10] 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.

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

[12] ISO 13 528. *Statistical methods for use in proficiency testing by interlaboratory comparisons.* 2005.

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1 Appendix – EN ISO 17892-1 – Water content

1.1 Test results

Table 3: Test results - ordered by average value. Outliers are marked by star. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
ce9f4e	6.3	6.7	7.4	2.3	6.8	0.6	8.19
0149da	7.0	6.7	6.9	0.5	6.9	0.2	2.22
50e96f	7.0	6.9	6.8	0.7	6.9	0.1	1.45
832a77	7.1	7.1	7.1	-	7.1	0.0	0.00
8b6464	7.5	6.6	7.3	0.9	7.1	0.5	6.62
20fbb6	7.1	7.3	7.2	0.3	7.2	0.1	1.39
381a49	5.8	6.8	9.0*	0.1	7.2	1.6	22.74
3490e6	7.4	7.3	7.5	0.2	7.4	0.1	1.35
5dc8ae	7.4	7.5	7.4	0.2	7.4	0.1	0.78
a3887b	7.7	7.3	7.5	0.5	7.5	0.2	2.67
39a58b	7.7	7.3	7.6	-	7.5	0.2	2.23
f9c800	7.5	7.6	7.6	-	7.6	0.0	0.55

1.2 The Numerical Procedure for Determining Outliers
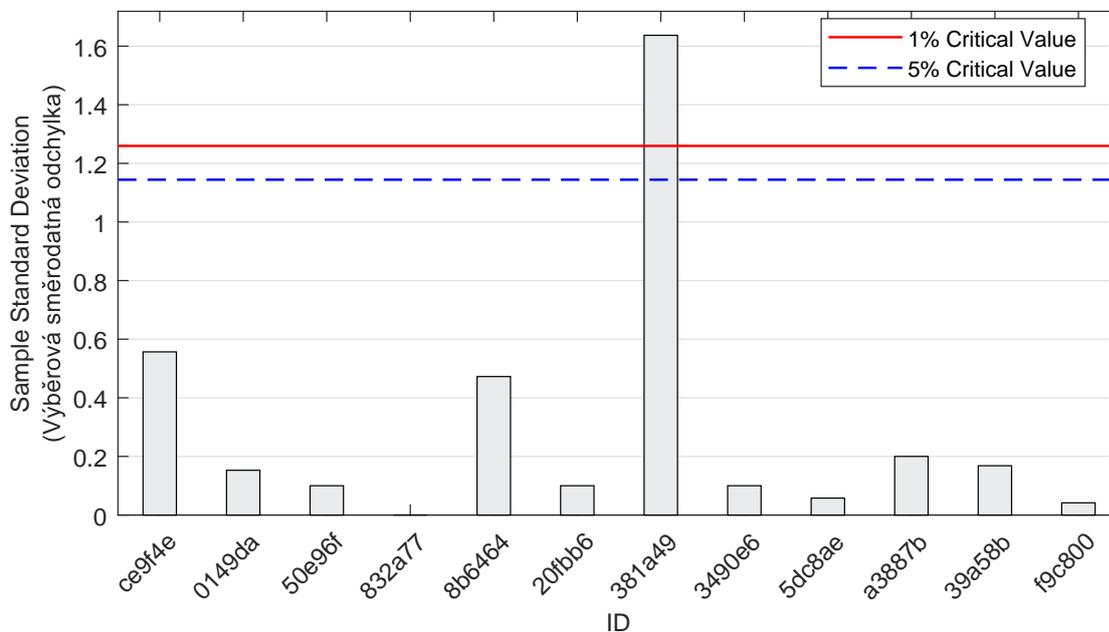
Figure 1: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

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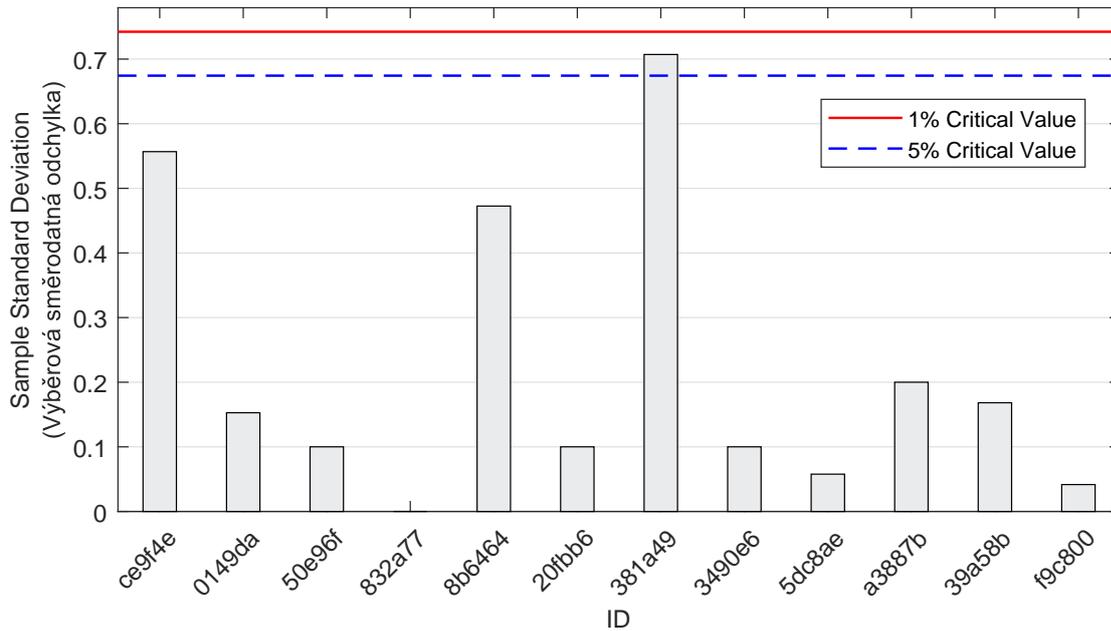
Figure 2: **Cochran's test** - sample standard deviations without outliers: 1% critical value - red color; 5% critical value - blue color
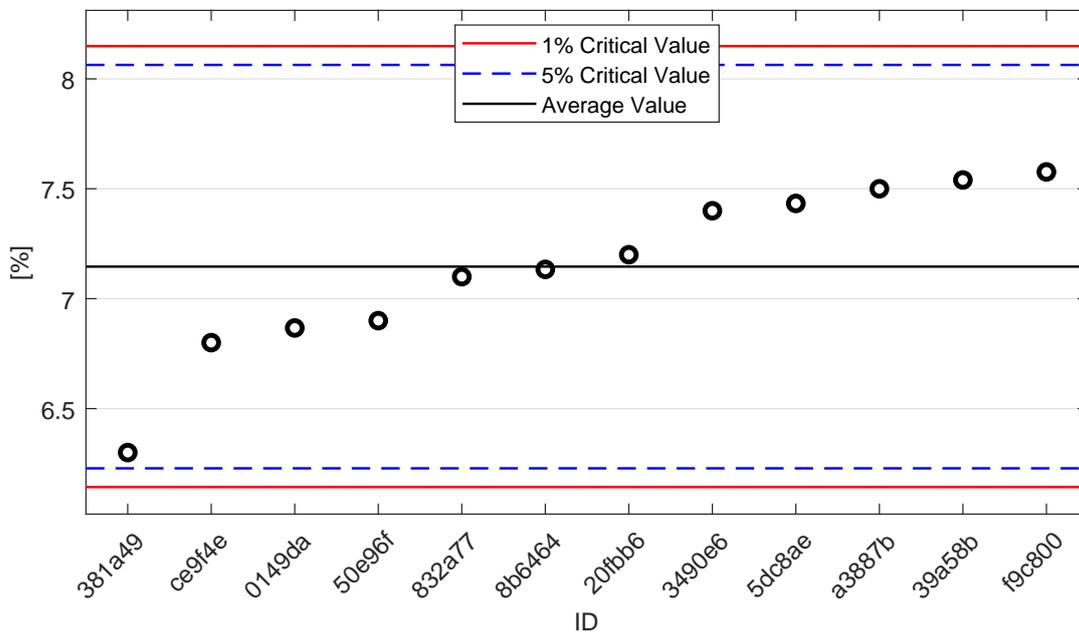
Figure 3: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

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1.3 Mandel's Statistics
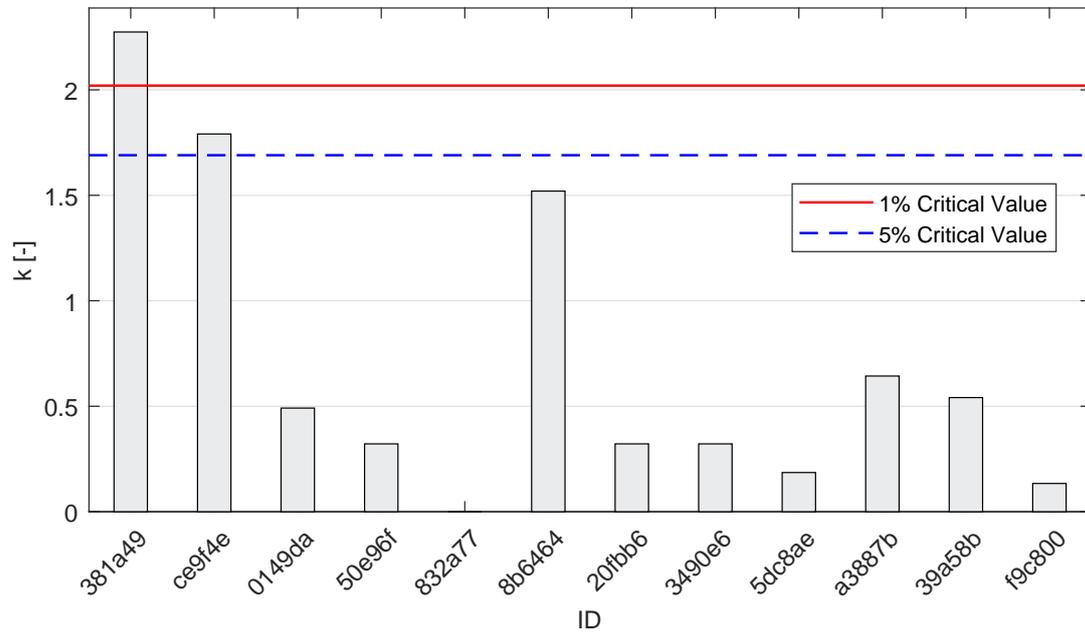
Figure 4: Intralaboratory Consistency Statistic *k*: 1% critical value - red color; 5% critical value - blue color
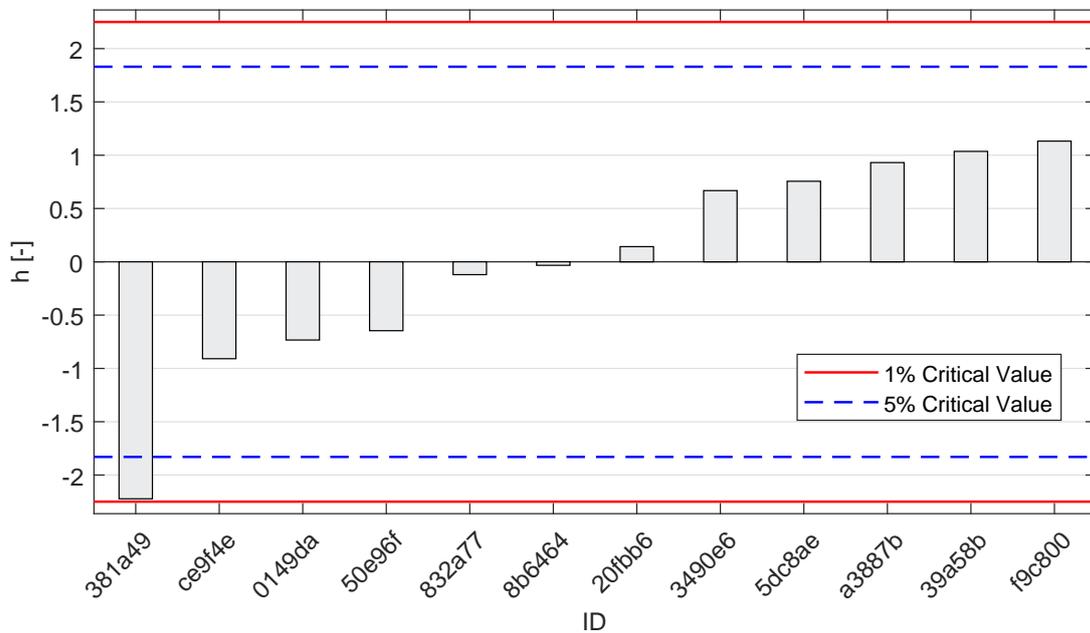
Figure 5: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

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1.4 Calculation of Performance Statistics
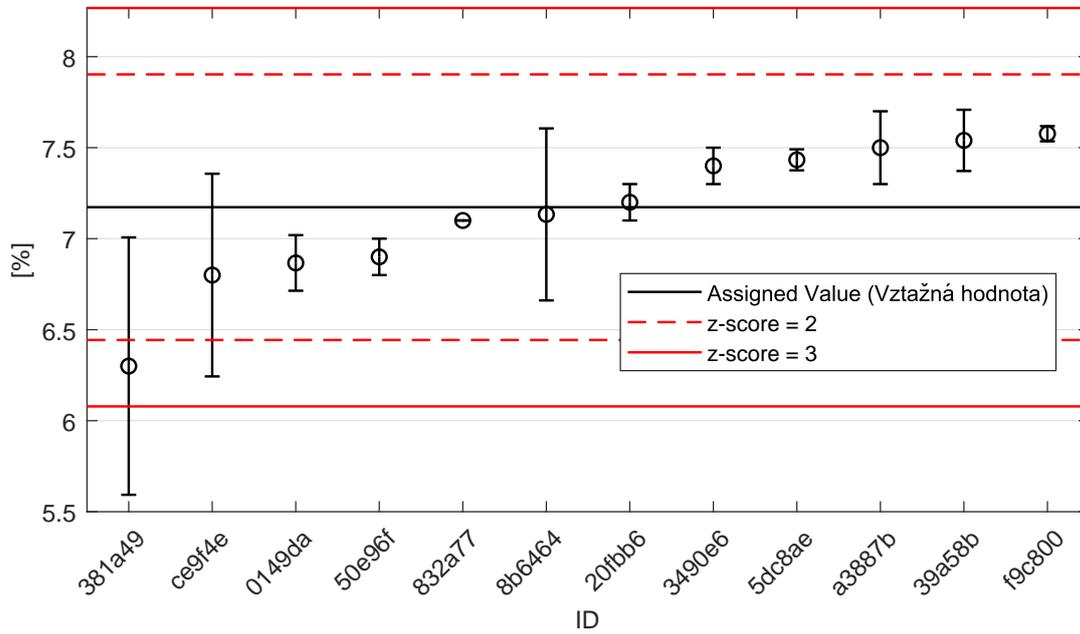
Figure 6: Average values and sample standard deviations
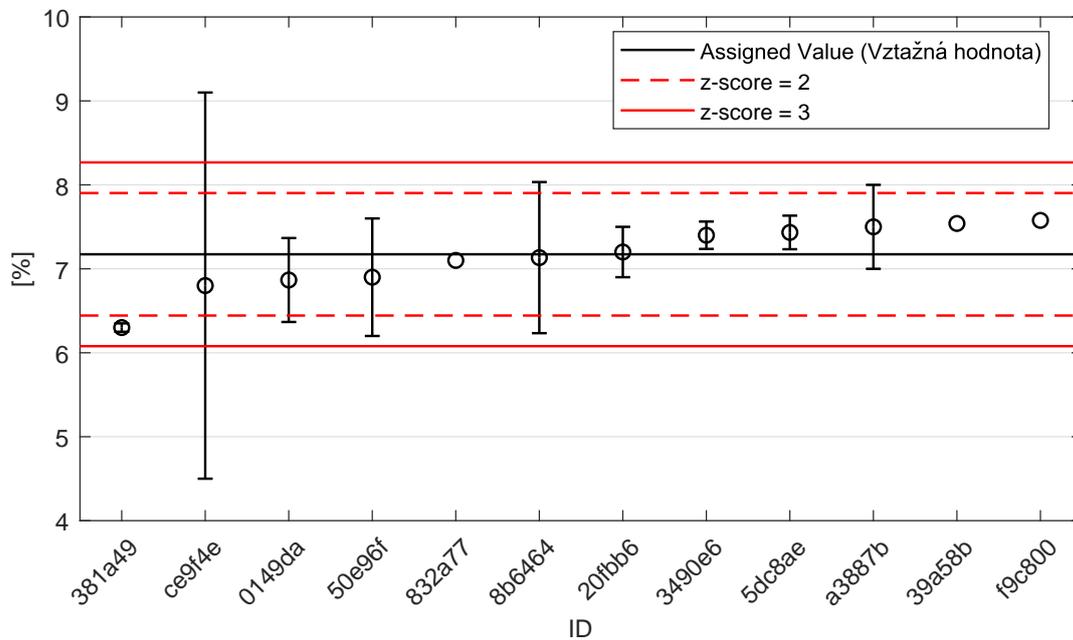
Figure 7: Average values and extended uncertainties of measurement

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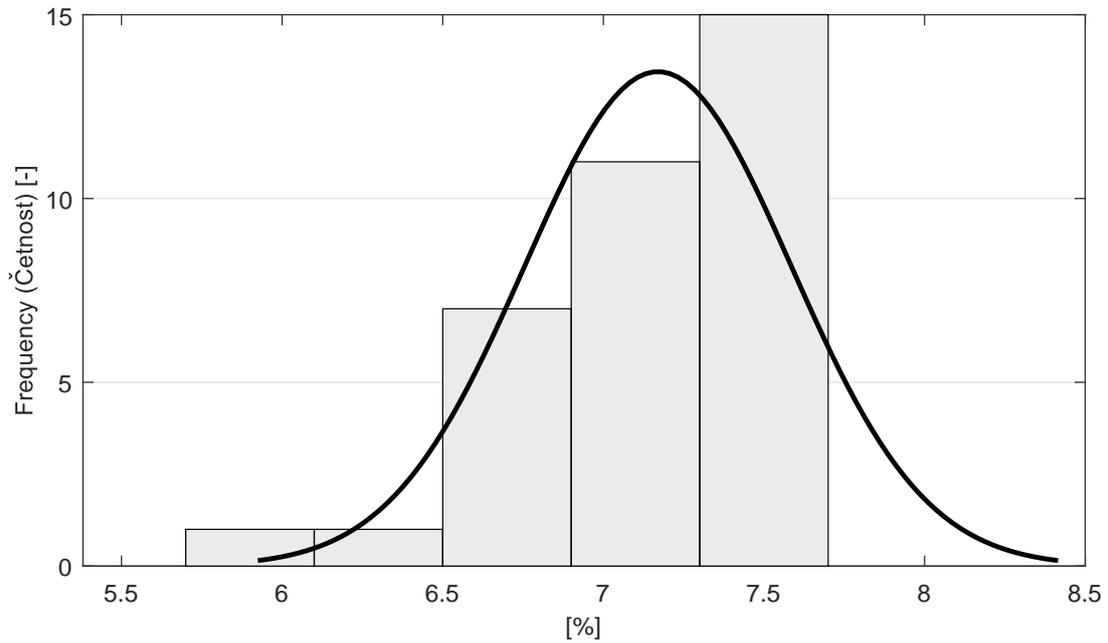
Figure 8: Histogram of all test results

Figure 9: z-score and ζ-score

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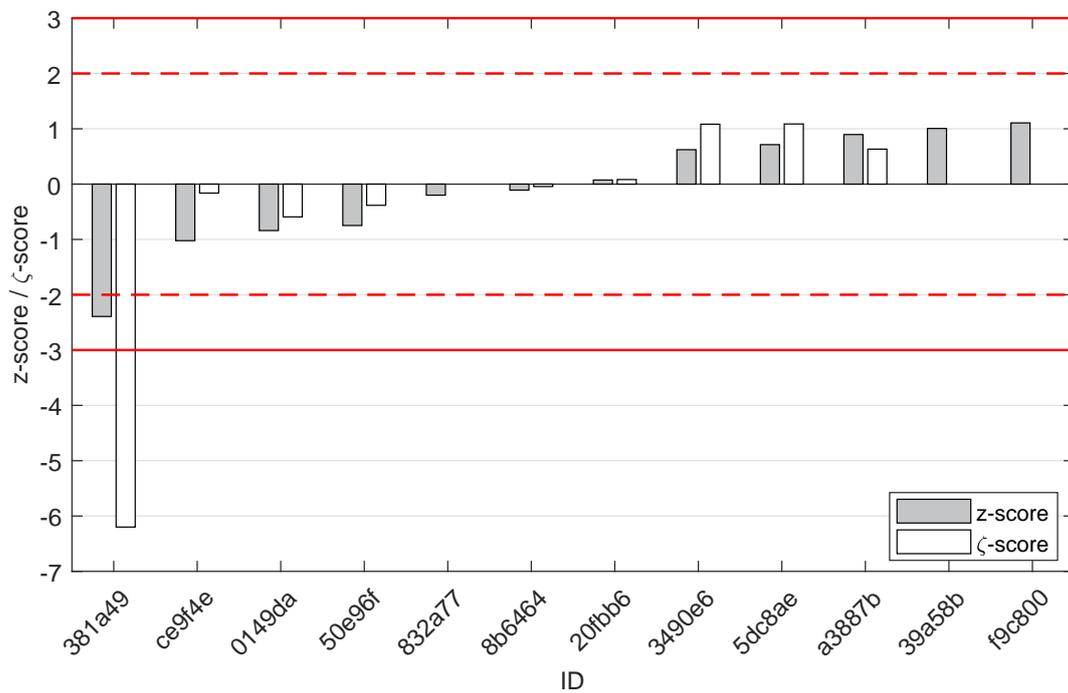
Table 4: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
381a49	-2.39	-6.20
ce9f4e	-1.02	-0.16
0149da	-0.84	-0.59
50e96f	-0.75	-0.38
832a77	-0.20	-
8b6464	-0.11	-0.04
20fbb6	0.07	0.08
3490e6	0.62	1.08
5dc8ae	0.71	1.09
a3887b	0.90	0.63
39a58b	1.01	-
f9c800	1.11	-

2 Appendix – EN ISO 17892-3 – Particle density

2.1 Test results

Table 5: Test results - ordered by average value. Outliers are marked by star. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [Mg/m^3]			u_X [Mg/m^3]	$\bar{x}$ [Mg/m^3]	s_0 [Mg/m^3]	V_X [%]
7b64ea	2.61	2.61	2.62	0.02	2.61	0.01	0.22
381a49	2.62	2.66	2.61	0.02	2.63	0.03	1.01
da116f	2.64	2.65	2.64	-	2.65	0.01	0.23
042826	2.66	2.62	2.69	0.10	2.66	0.04	1.32
20d0e7	2.66	2.67	2.66	-	2.66	0.00	0.09
39a58b	2.68	2.68	2.68	-	2.68	0.00	0.15
0149da	2.68	2.68	2.68	0.03	2.68	0.00	0.00
3490e6	2.69	2.69	2.69	0.26	2.69	0.00	0.00
832a77	2.70	2.69	2.69	-	2.69	0.00	0.04
8b6464	2.70	2.71	2.70	0.01	2.70	0.00	0.17
50e96f	2.72	2.72	2.72	0.01	2.72	0.00	0.00

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2.2 The Numerical Procedure for Determining Outliers
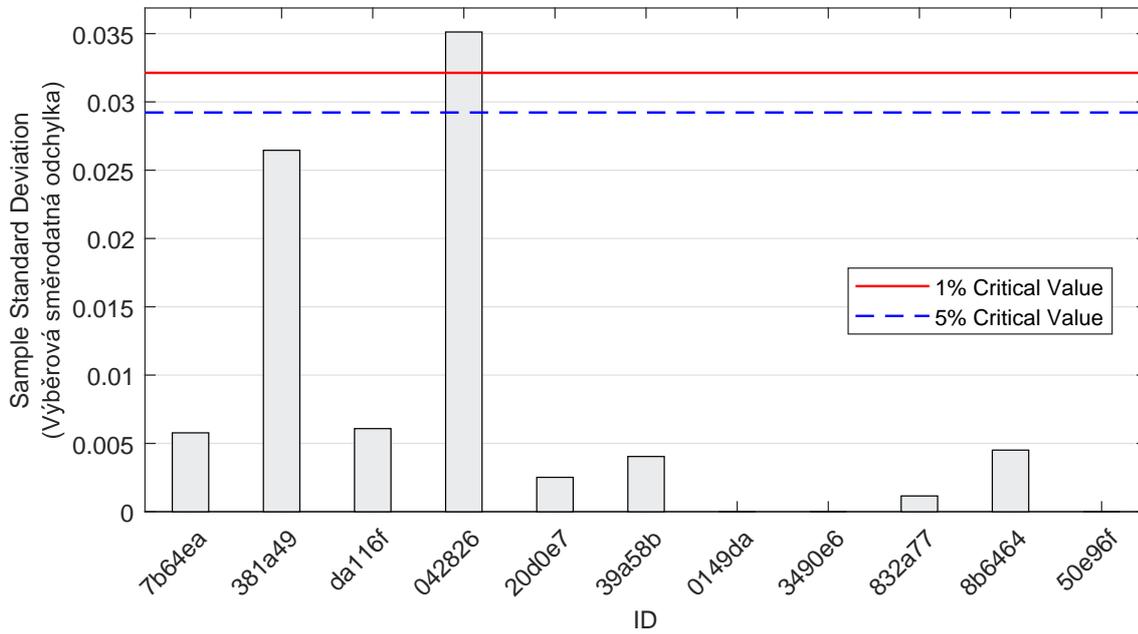
Figure 10: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
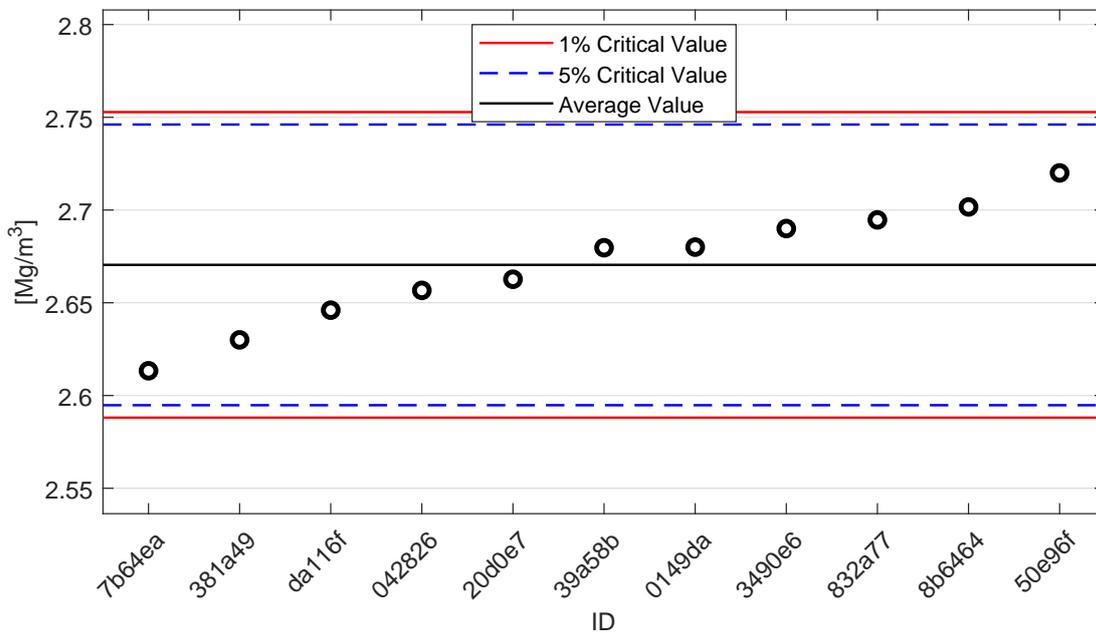
Figure 11: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

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2.3 Mandel's Statistics
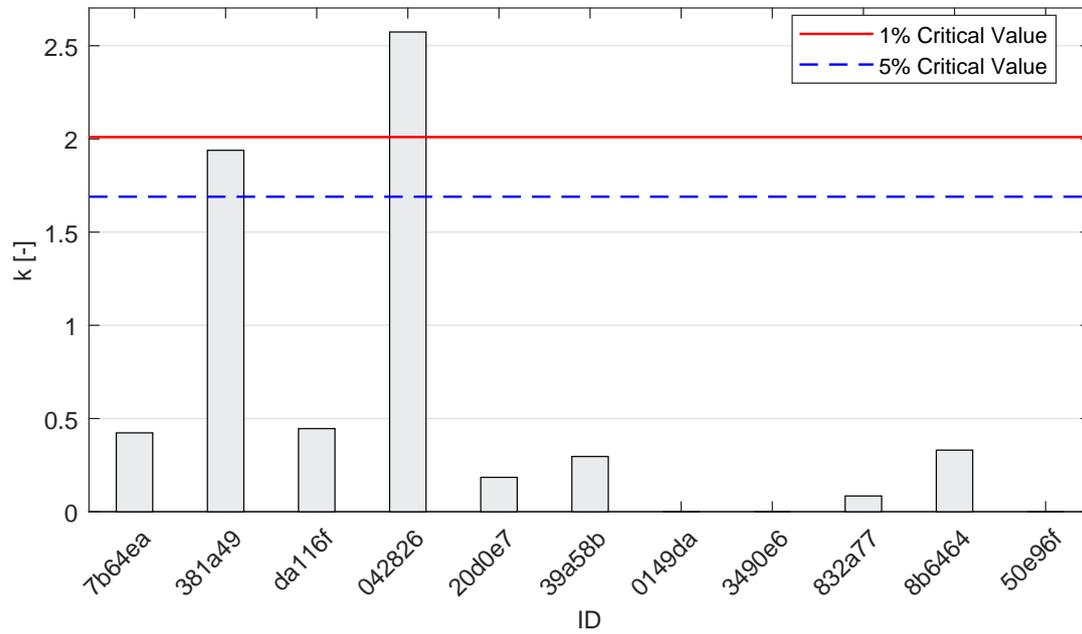
Figure 12: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color
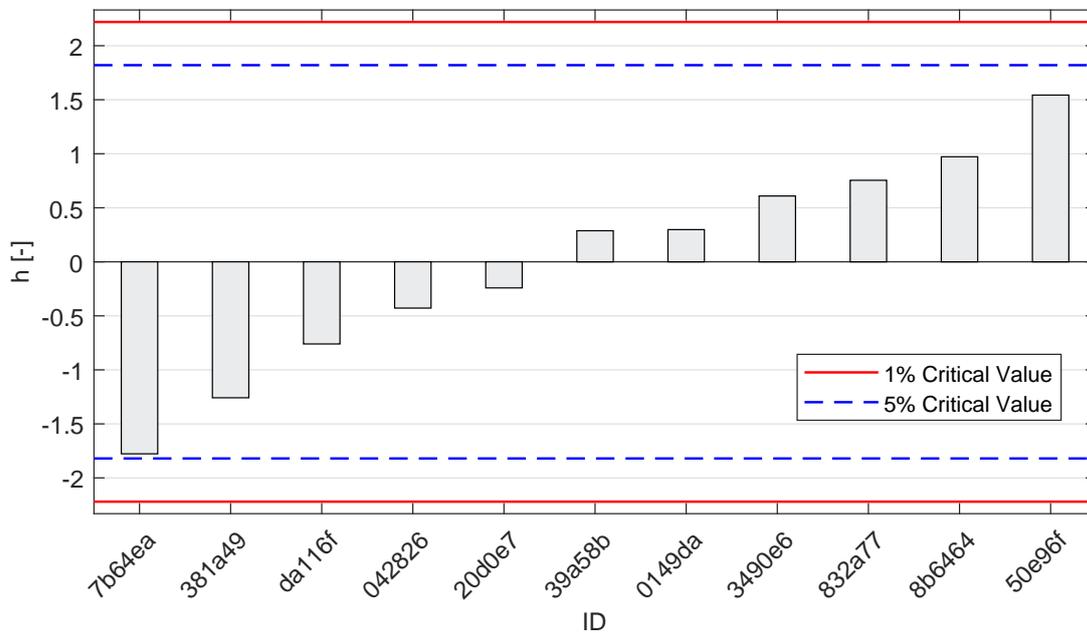
Figure 13: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

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2.4 Calculation of Performance Statistics
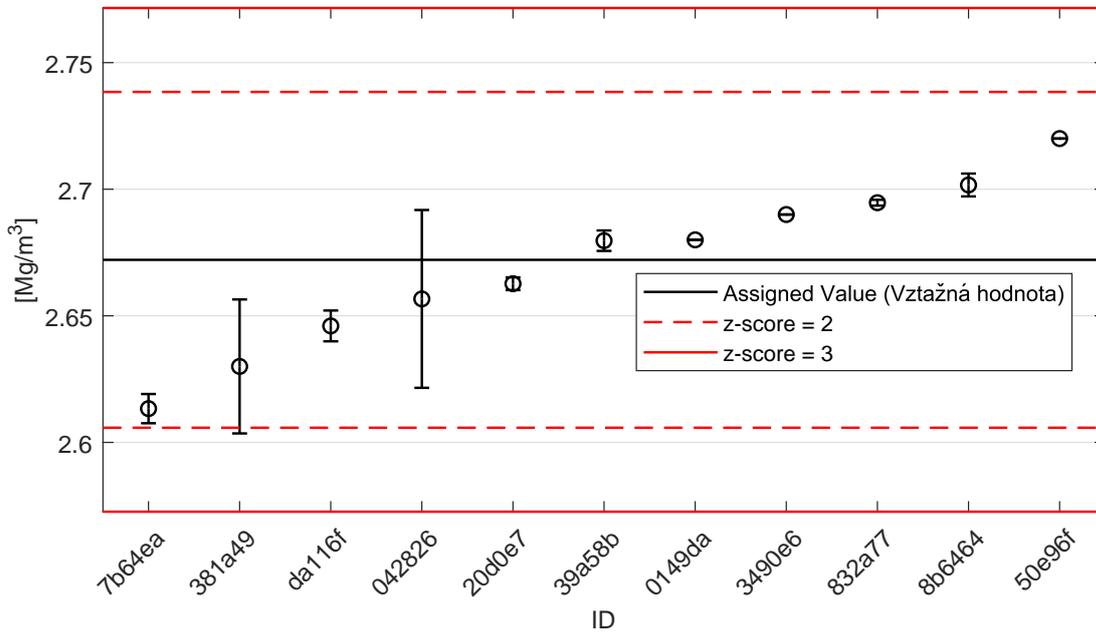
Figure 14: Average values and sample standard deviations
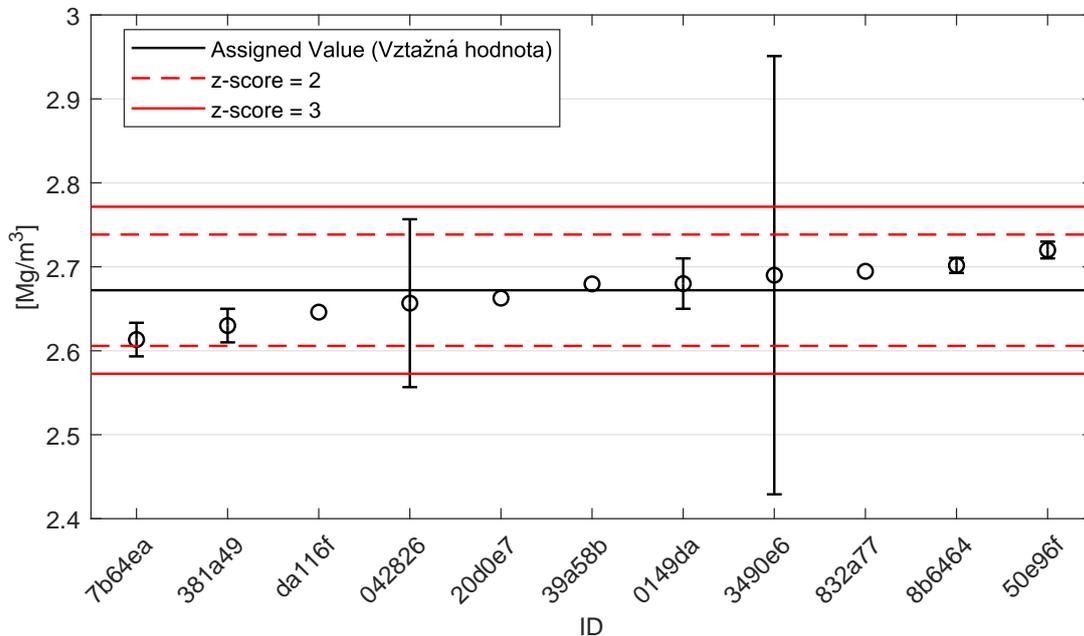
Figure 15: Average values and extended uncertainties of measurement

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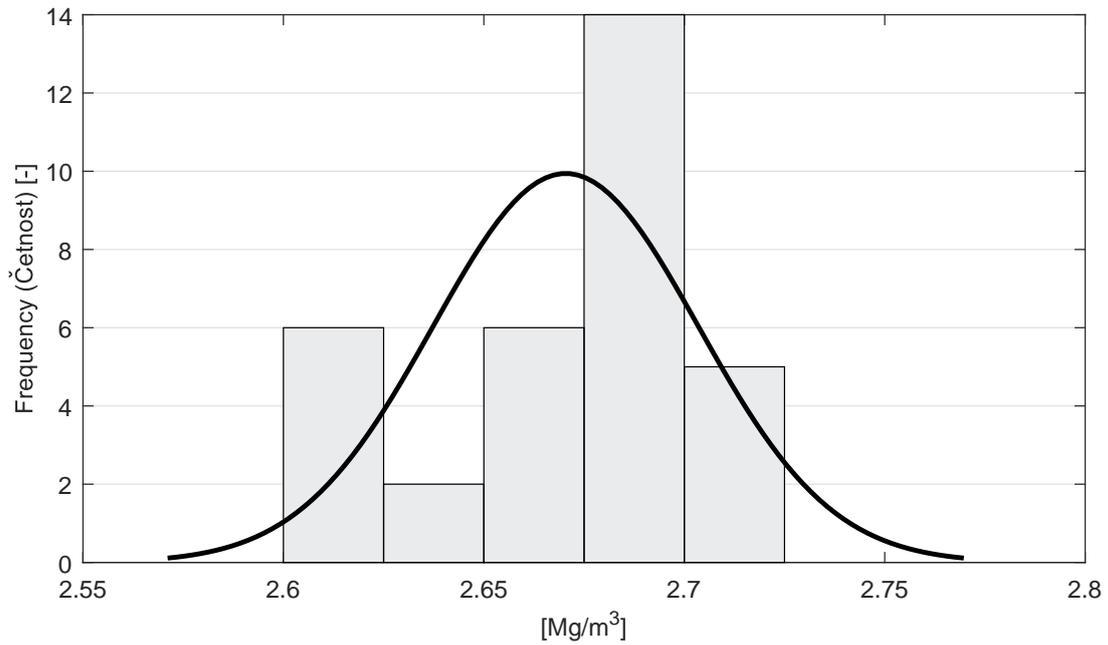
Figure 16: Histogram of all test results

Figure 17: z-score and ζ-score

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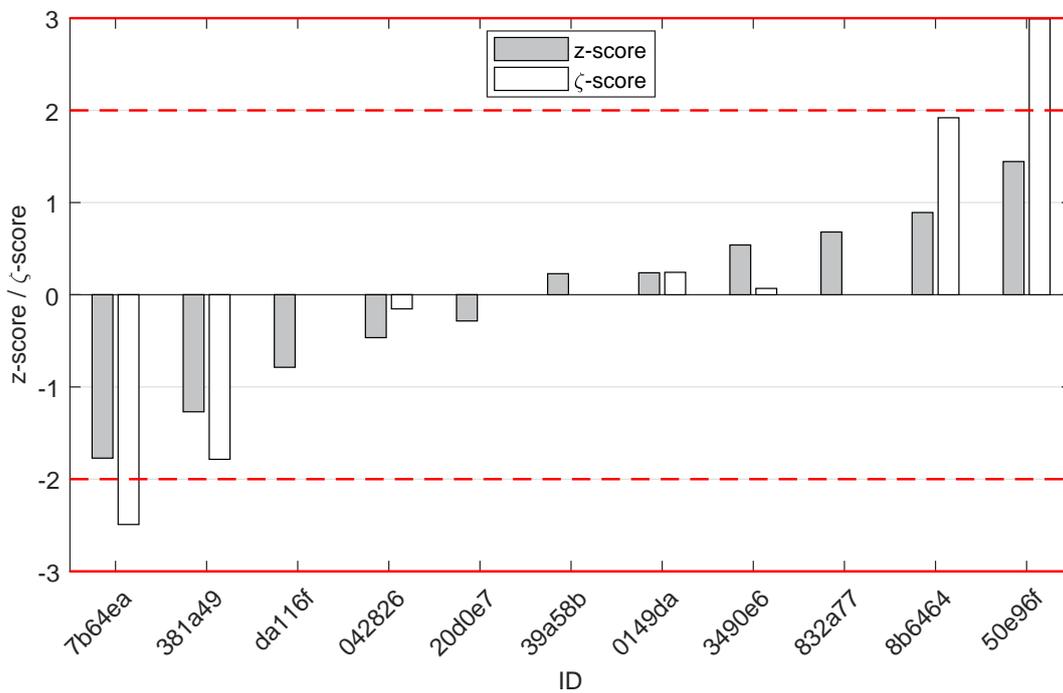
Table 6: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
7b64ea	-1.77	-2.49
381a49	-1.27	-1.79
da116f	-0.79	-
042826	-0.47	-0.15
20d0e7	-0.28	-
39a58b	0.23	-
0149da	0.24	0.24
3490e6	0.54	0.07
832a77	0.68	-
8b6464	0.89	1.92
50e96f	1.44	2.99

3 Appendix – EN ISO 17892-4 – Particle size distribution

3.1 Test results

Table 7: Test results - Sieve through [%]

ID of participant	8 mm	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
3490e6	99.8	96.3	83.9	58.5	28.5	5.8	0.7	0.1
a75426	100.0	95.9	83.9	61.9	35.0	12.4	3.2	1.8
20fbb6	100.0	96.0	84.0	61.8	35.4	13.7	4.6	2.5
39a58b	100.0	96.8	84.8	59.3	34.5	11.5	2.8	1.5
ac5ed6	100.0	96.0	83.0	61.0	34.0	11.0	2.0	1.1
832a77	100.0	95.4	82.9	60.1	33.8	12.1	3.8	1.9
0149da	100.0	96.0	83.1	59.4	32.1	12.9	3.1	1.8
042826	100.0	95.2	83.6	60.3	33.9	11.4	2.7	1.4
da116f	100.0	95.3	82.4	65.7	31.8	8.2	1.2	0.4
a3887b	100.0	95.8	83.1	59.3	33.4	9.0	2.6	1.3
8b6464	100.0	95.1	82.7	63.2	34.8	12.9	3.0	1.4
50e96f	100.0	94.8	81.9	58.9	31.0	7.5	1.0	0.2
381a49	-	95.1	81.4	62.5	32.8	11.2	2.6	1.5

Table 8: Grubbs' test [%]

Value	8 mm	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
G_{min}	-	1.496	1.873	1.163	2.424	2.071	1.693	1.724
G_{max}	-	1.991	1.802	2.324	1.171	1.241	1.855	1.718
$G_{0.05}$	2.462	2.462	2.462	2.462	2.462	2.462	2.462	2.462
$G_{0.01}$	2.699	2.699	2.699	2.699	2.699	2.699	2.699	2.699

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Table 9: *z*-score

ID	*z*-score [-] / sieve							
of participant	8 mm	4 mm	2 mm	1 mm	0.5 mm	0.25 mm	0.125 mm	0.063 mm
3490e6	-3.18	1.11	0.84	-1.16	-2.42	-2.07	-1.69	-1.72
a75426	0.29	0.41	0.84	0.48	0.96	0.70	0.58	0.71
20fbb6	0.29	0.59	0.95	0.43	1.17	1.24	1.85	1.72
39a58b	0.29	1.99	1.80	-0.80	0.70	0.32	0.24	0.33
ac5ed6	0.29	0.59	-0.14	0.05	0.44	0.11	-0.51	-0.29
832a77	0.29	-0.52	-0.30	-0.41	0.35	0.58	1.09	0.84
0149da	0.29	0.57	-0.03	-0.75	-0.55	0.89	0.46	0.69
042826	0.29	-0.80	0.51	-0.29	0.39	0.28	0.13	0.14
da116f	0.29	-0.72	-0.77	2.32	-0.72	-1.06	-1.20	-1.26
a3887b	0.29	0.24	-0.03	-0.78	0.13	-0.73	0.04	0.00
8b6464	0.29	-0.98	-0.46	1.11	0.86	0.91	0.40	0.14
50e96f	0.29	-1.50	-1.33	-0.97	-1.12	-1.36	-1.42	-1.58
381a49	-	-0.98	-1.87	0.77	-0.18	0.19	0.04	0.28

4 Appendix – EN ISO 17892-5 – Incremental loading oedometer test

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

5 Appendix – EN ISO 17892-7 – Unconfined compressive strength, Strain at failure

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

6 Appendix – CEN ISO/TS 17892-10 – Effective shear parameters

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

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7 Appendix – EN ISO 17892-12 – Atterberg limits

7.1 Liquit limit

7.1.1 Test results

Table 10: Test results - ordered by average value. Outliers are marked by star. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
d6e1e1	30.4	30.5	30.6	0.4	30.5	0.1	0.35
3490e6	33.0	33.0	32.0	0.4	32.7	0.6	1.77
da116f	33.5	33.4	34.3	-	33.7	0.5	1.46
387c59	33.3	33.4	35.5	-	34.1	1.2	3.65
832a77	34.0	34.1	34.2	-	34.1	0.1	0.29
381a49	35.0	34.2	33.4	0.8	34.2	0.8	2.34
45b885	35.0	35.0	35.0	1.0	35.0	0.0	0.00
20fbb6	35.0	36.0	35.0	0.6	35.3	0.6	1.63
b3a991	35.7	35.5	35.0	0.4	35.4	0.4	1.02
ce9f4e	35.9	35.4	36.3	1.8	35.9	0.5	1.26
0149da	38.0	37.0	37.0	2.0	37.3	0.6	1.55
8b6464	38.7	37.9	37.4	1.7	38.0	0.7	1.73
39a58b	38.2	38.3	38.3	-	38.3	0.1	0.22
50e96f	38.7	38.2	38.6	1.6	38.5	0.3	0.69
ac5ed6	39.0	40.0	40.0	0.8	39.7	0.6	1.46
45cad1	40.0	39.0	40.0	0.8	39.7	0.6	1.46

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### 7.1.2 The Numerical Procedure for Determining Outliers
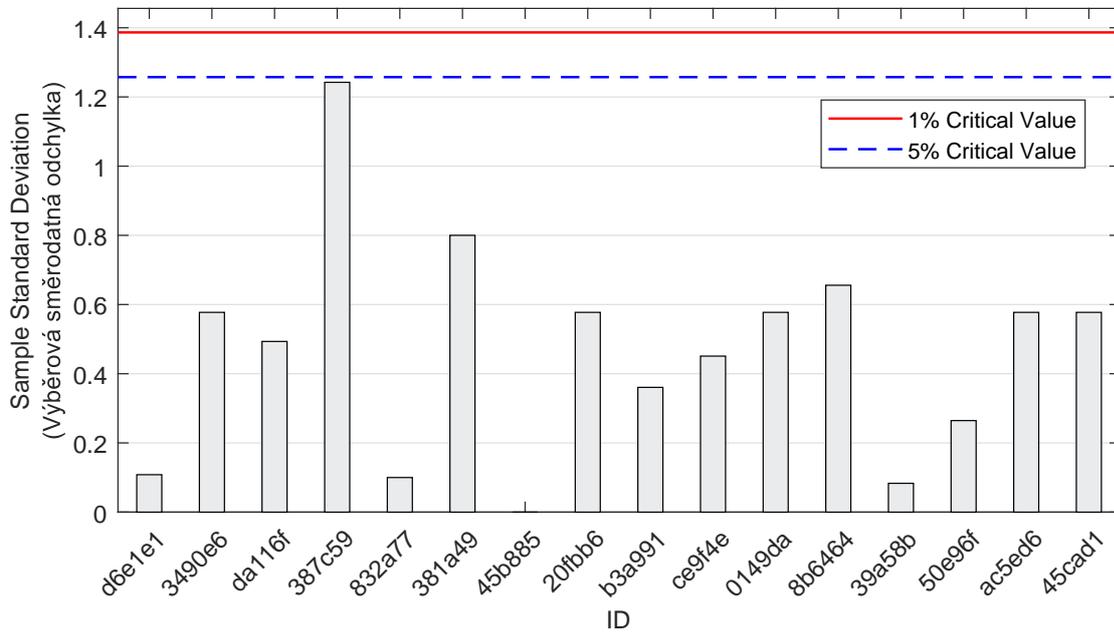
Figure 18: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
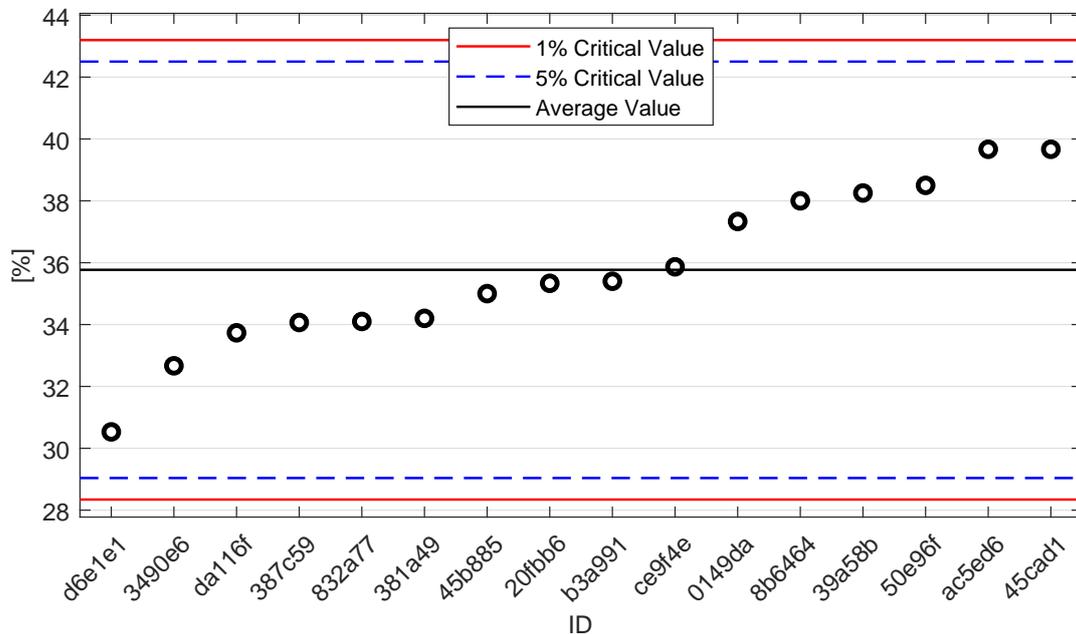

Figure 19: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

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7.1.3 Mandel's Statistics
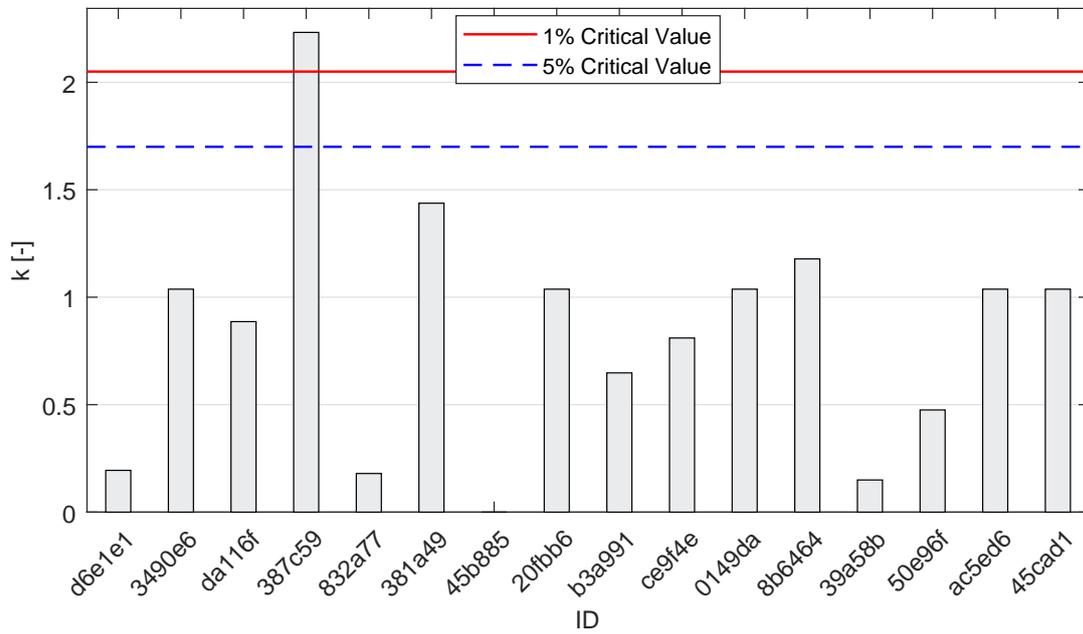
Figure 20: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color
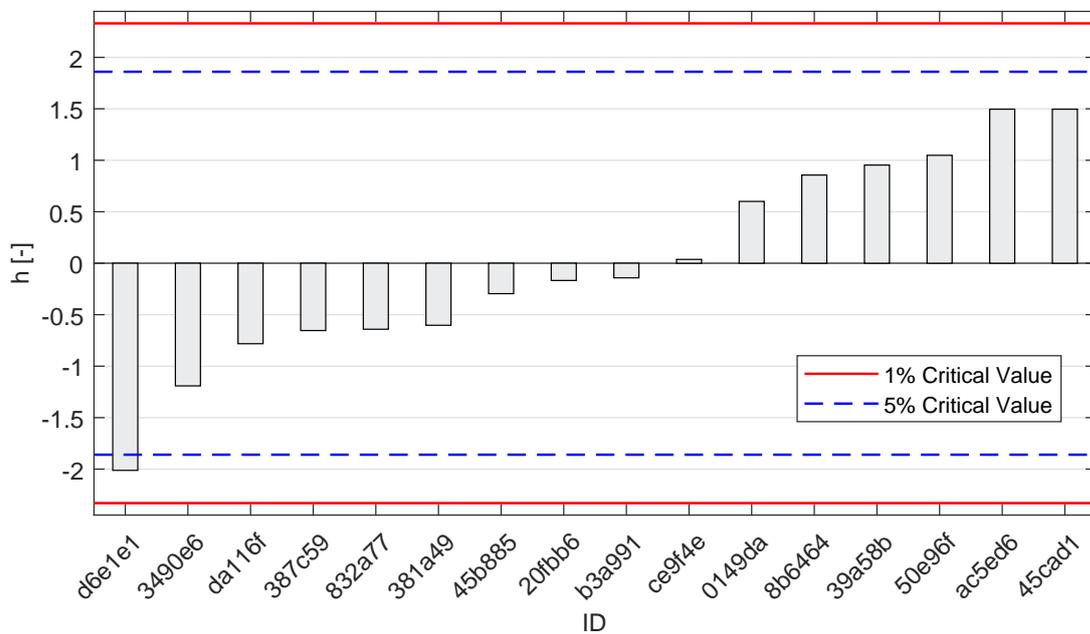
Figure 21: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

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7.1.4 Calculation of Performance Statistics
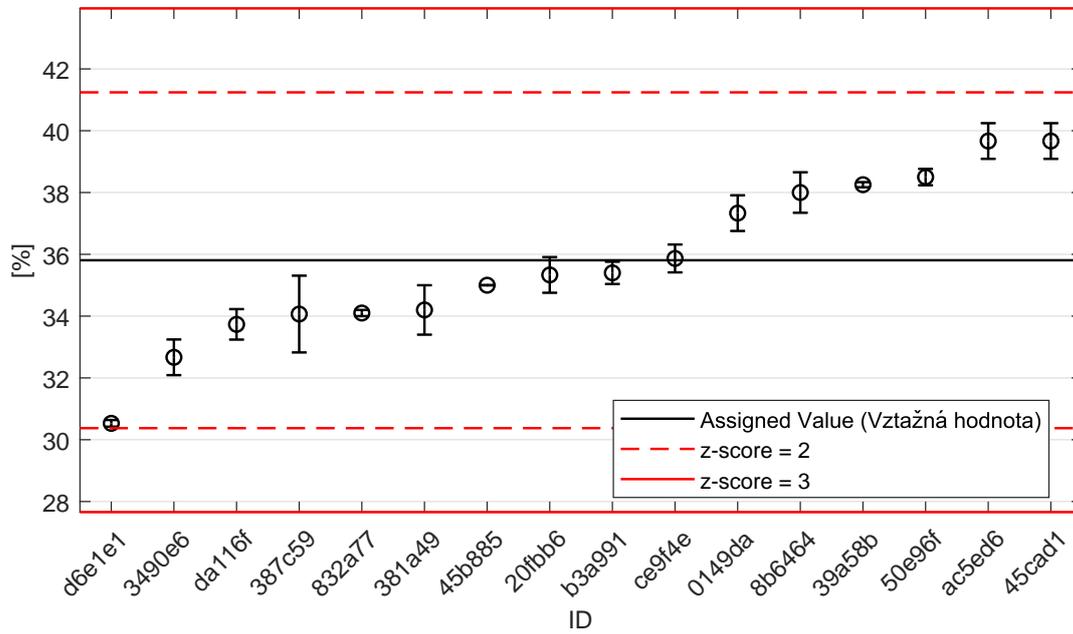

Figure 22: Average values and sample standard deviations
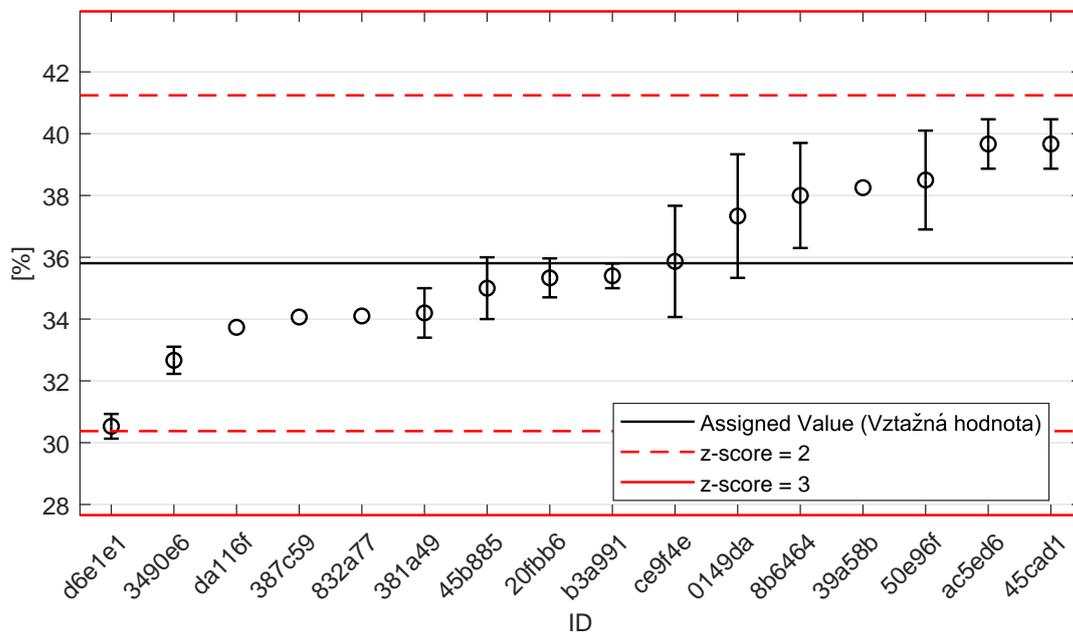
Figure 23: Average values and extended uncertainties of measurement

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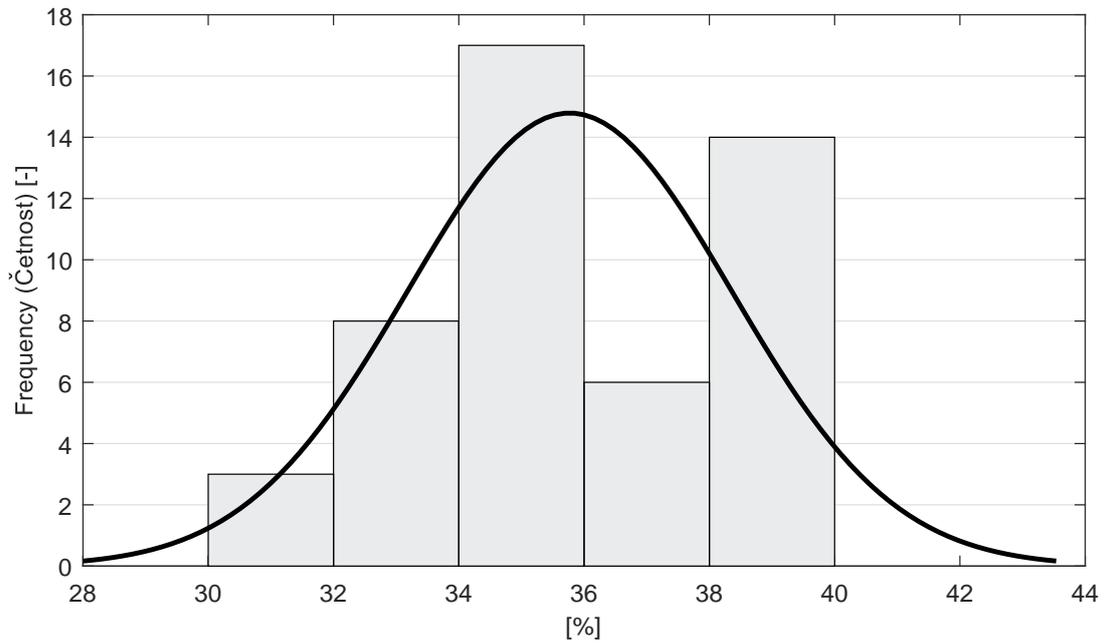
Figure 24: Histogram of all test results
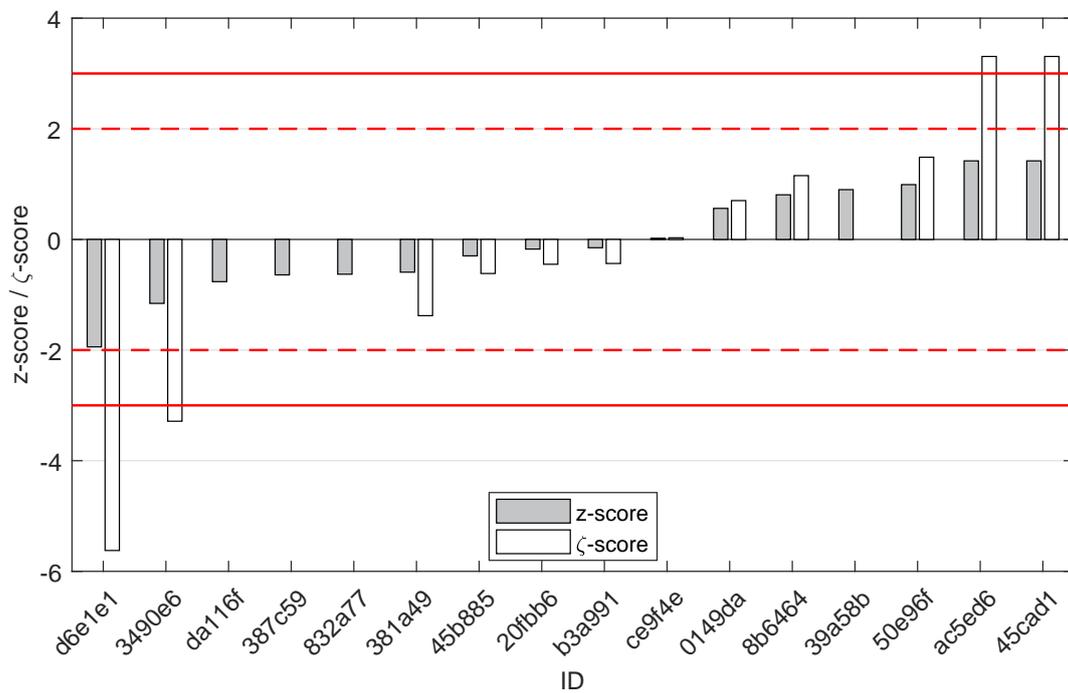
Figure 25: z-score and ζ-score

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Table 11: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
d6e1e1	-1.94	-5.62
3490e6	-1.16	-3.29
da116f	-0.76	-
387c59	-0.64	-
832a77	-0.63	-
381a49	-0.59	-1.38
45b885	-0.30	-0.62
20fbb6	-0.17	-0.45
b3a991	-0.15	-0.43
ce9f4e	0.02	0.03
0149da	0.56	0.70
8b6464	0.81	1.15
39a58b	0.90	-
50e96f	0.99	1.49
ac5ed6	1.42	3.31
45cad1	1.42	3.31

7.2   Plastic limit

7.2.1   Test results

Table 12: Test results - ordered by average value. Outliers are marked by star. u_X - extended uncertainty of measurement; $\bar{x}$ - average value; s_0 - sample standard deviation; V_X - variation coefficient

ID of participant	Test results [%]			u_X [%]	$\bar{x}$ [%]	s_0 [%]	V_X [%]
ce9f4e	17.8	18.1	18.7	3.0	18.2	0.5	2.52
d6e1e1	19.1	19.0	18.5	0.5	18.9	0.3	1.70
20fbb6	20.0	19.0	19.0	0.8	19.3	0.6	2.99
da116f	19.2	19.3	20.1	-	19.5	0.5	2.61
45b885	20.0	20.0	19.0	1.0	19.7	0.6	2.94
381a49	20.5	19.2	20.1	0.6	19.9	0.7	3.34
0149da	20.0	20.0	20.0	4.0	20.0	0.0	0.00
8b6464	19.9	20.9	20.1	1.4	20.3	0.5	2.61
3490e6	21.0	20.0	20.0	0.4	20.3	0.6	2.84
832a77	21.0	21.1	21.3	-	21.1	0.2	0.72
45cad1	21.0	22.0	21.0	1.1	21.3	0.6	2.71
39a58b	21.9	21.0	21.3	-	21.4	0.5	2.21
b3a991	21.2	21.5	21.6	0.2	21.4	0.2	0.97
50e96f	22.0	21.4	21.1	1.5	21.5	0.5	2.13
387c59	21.4	21.5	21.9	-	21.6	0.3	1.22
ac5ed6	21.0	22.0	23.0	0.7	22.0	1.0	4.55

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### 7.2.2 The Numerical Procedure for Determining Outliers
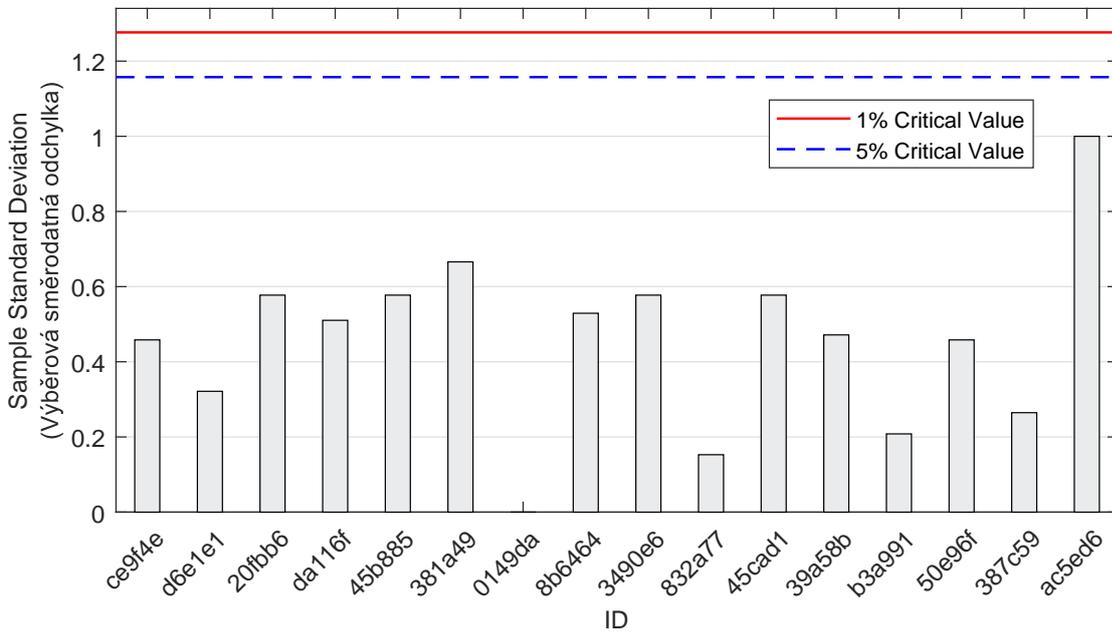
Figure 26: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
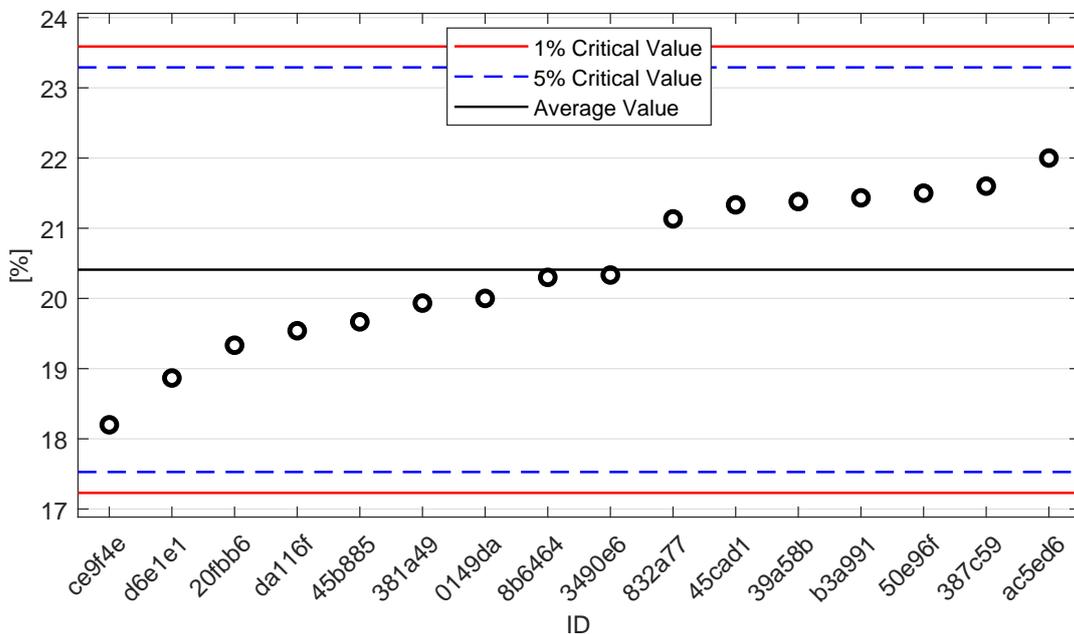

Figure 27: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

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7.2.3   Mandel's Statistics
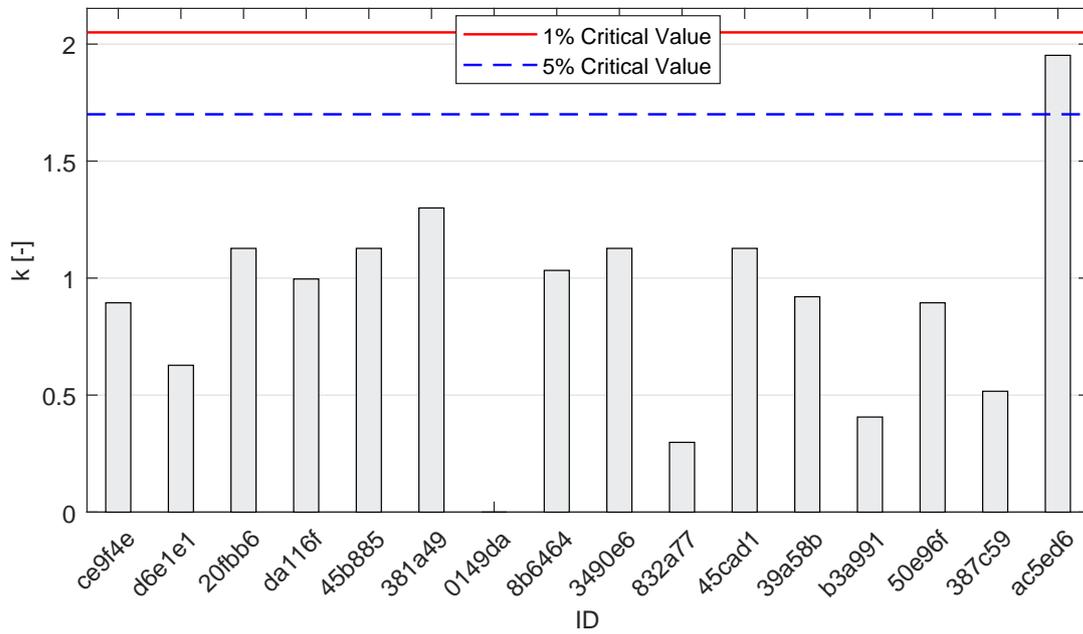
Figure 28: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color
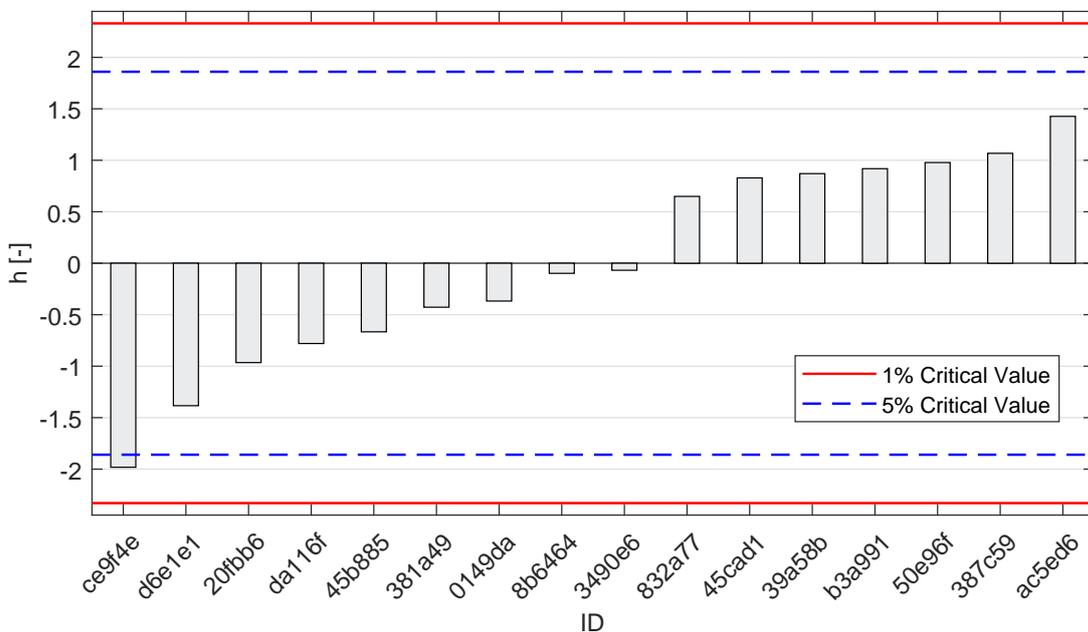
Figure 29: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

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7.2.4   Calculation of Performance Statistics
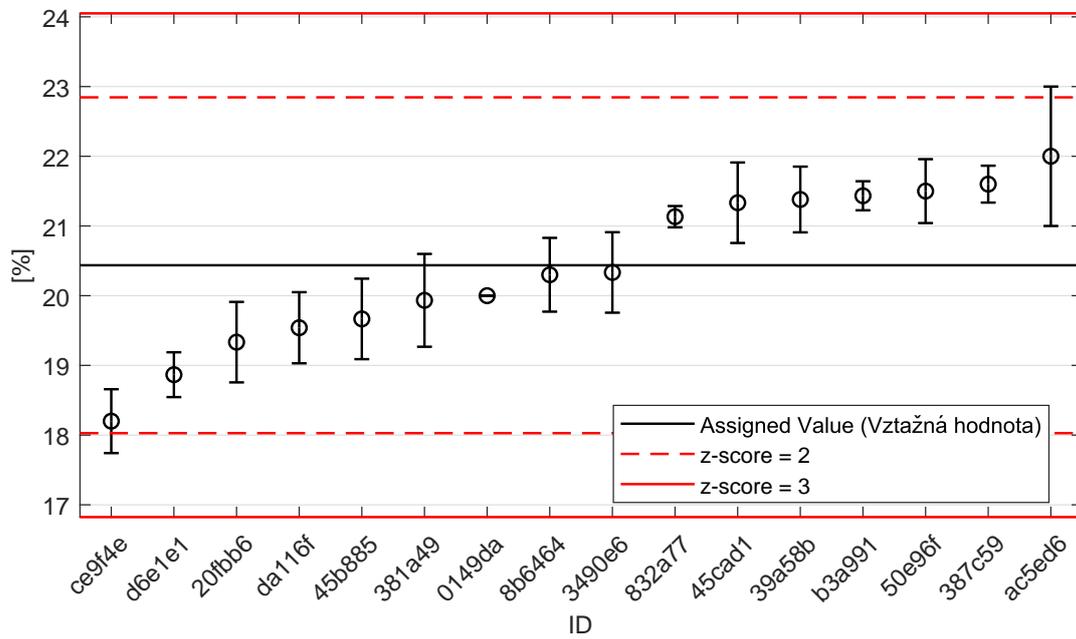


Figure 30: Average values and sample standard deviations
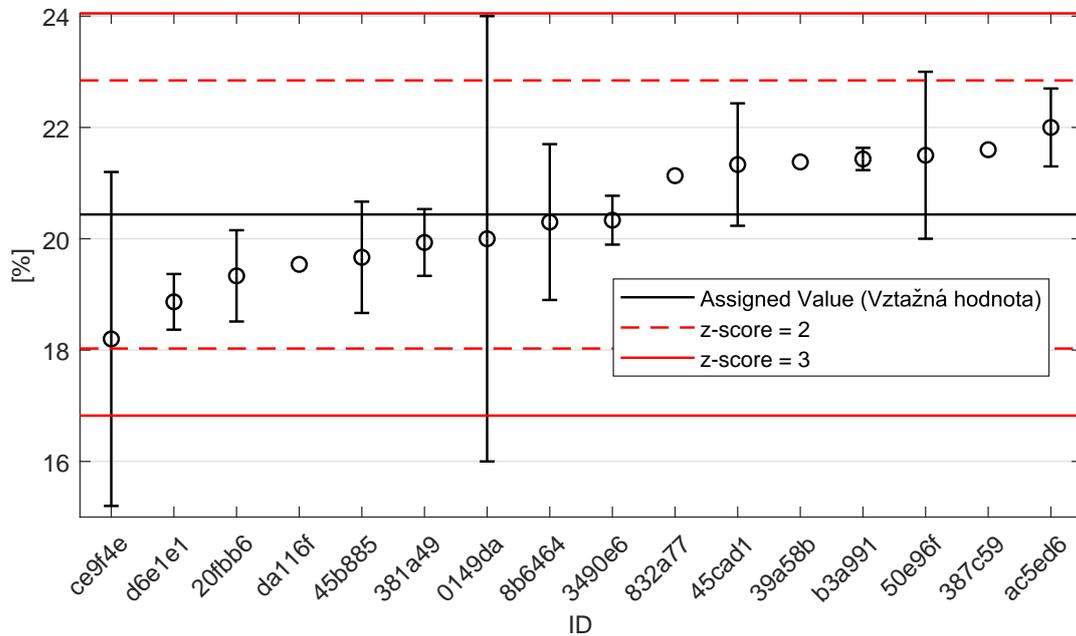
Figure 31: Average values and extended uncertainties of measurement

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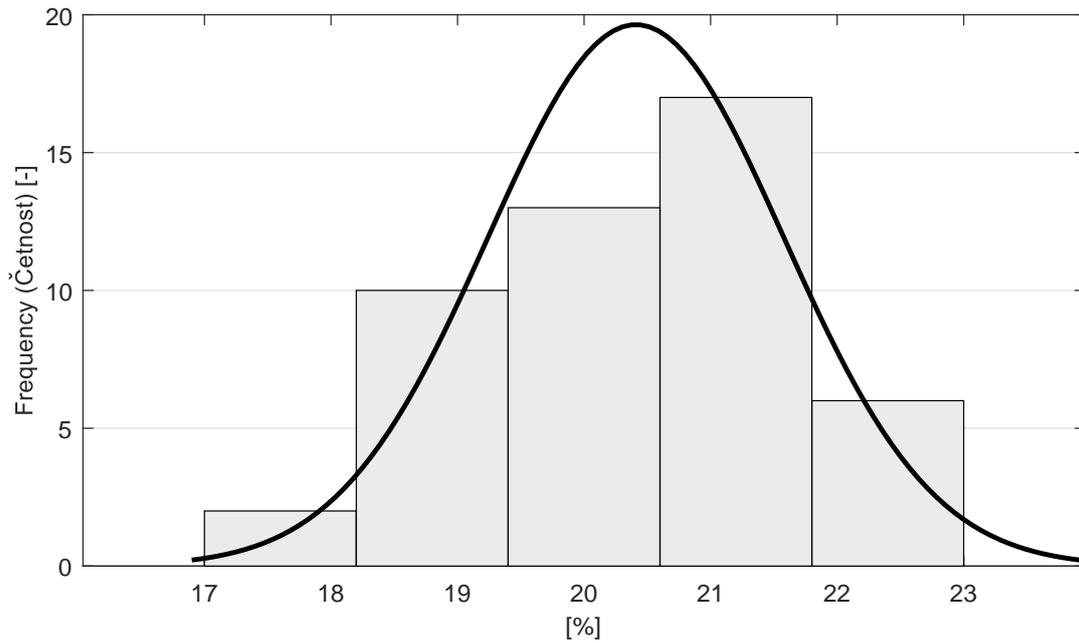
Figure 32: Histogram of all test results
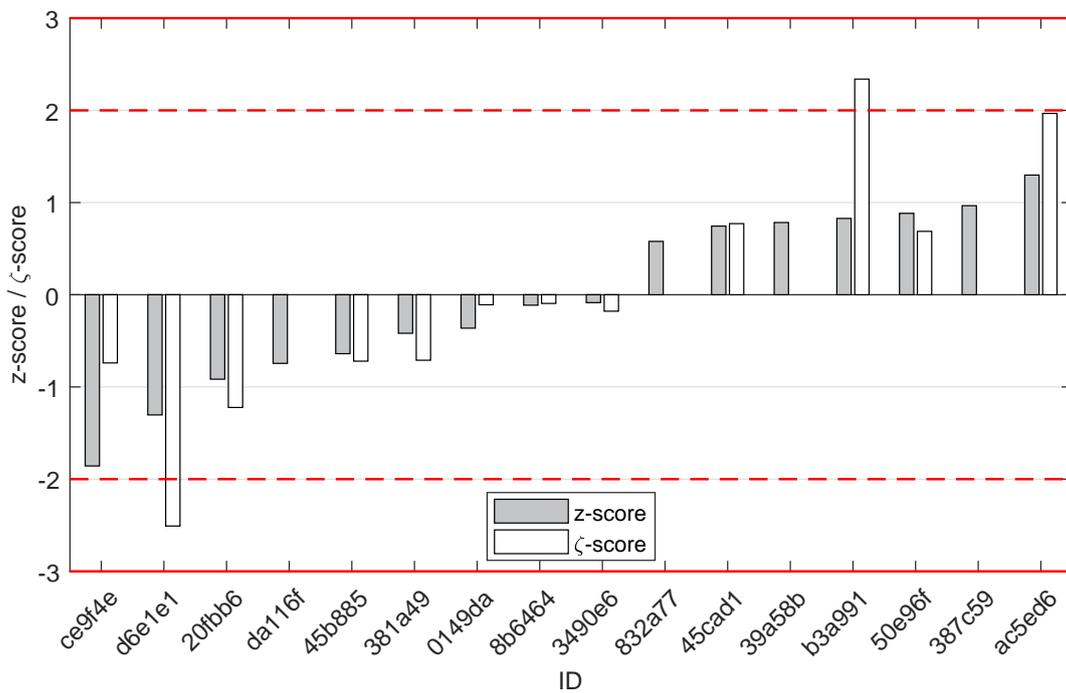
Figure 33: z-score and ζ-score

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Table 13: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
ce9f4e	-1.86	-0.74
d6e1e1	-1.30	-2.51
20fbb6	-0.92	-1.22
da116f	-0.74	-
45b885	-0.64	-0.72
381a49	-0.42	-0.71
0149da	-0.36	-0.11
8b6464	-0.11	-0.09
3490e6	-0.09	-0.18
832a77	0.58	-
45cad1	0.74	0.77
39a58b	0.78	-
b3a991	0.83	2.34
50e96f	0.88	0.69
387c59	0.97	-
ac5ed6	1.30	1.97

8 Appendix – EN 13286-2 – Proctor

8.1 Proctor density

8.1.1 Test results

Table 14: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [kg/m^3]	u_X [kg/m^3]
381a49	1680	-
832a77	1714	-
c75b1d	1720	34
50e96f	1742	25
3490e6	1750	0
a53b17	1750	-
0149da	1750	50
45cad1	1750	53
5dc8ae	1750	50
8b6464	1751	18
d6e1e1	1765	0
06ca53	1770	7
39a58b	1789	-

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### 8.1.2 The Numerical Procedure for Determining Outliers
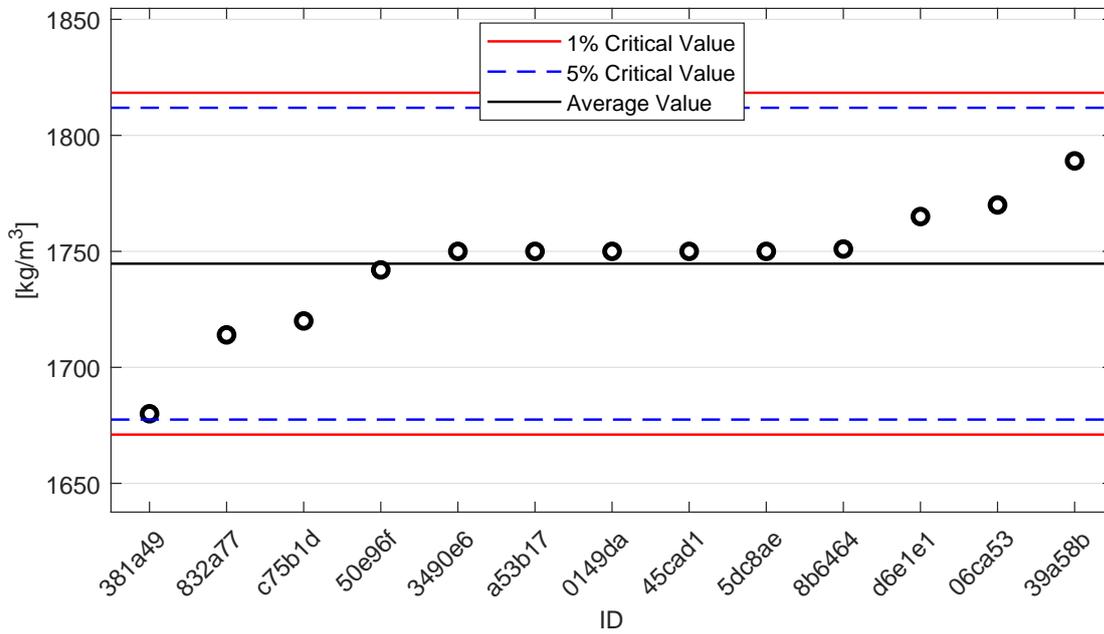
Figure 34: **Grubbs' test**: 1% critical value - red color; 5% critical value - blue color

8.1.3 Mandel's Statistics
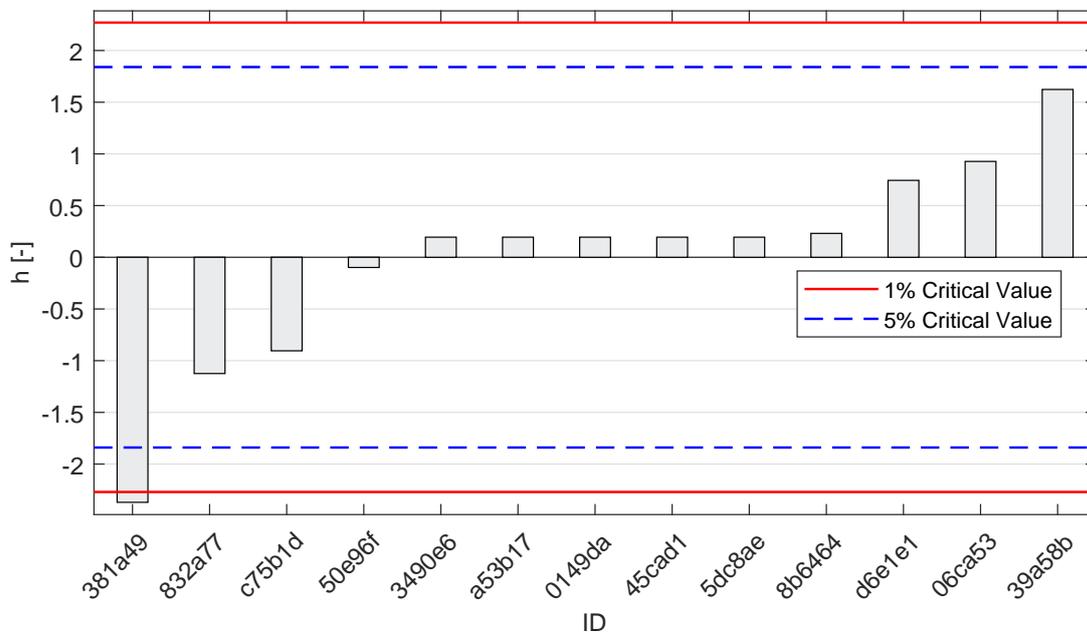
Figure 35: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

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8.1.4 Calculation of Performance Statistics
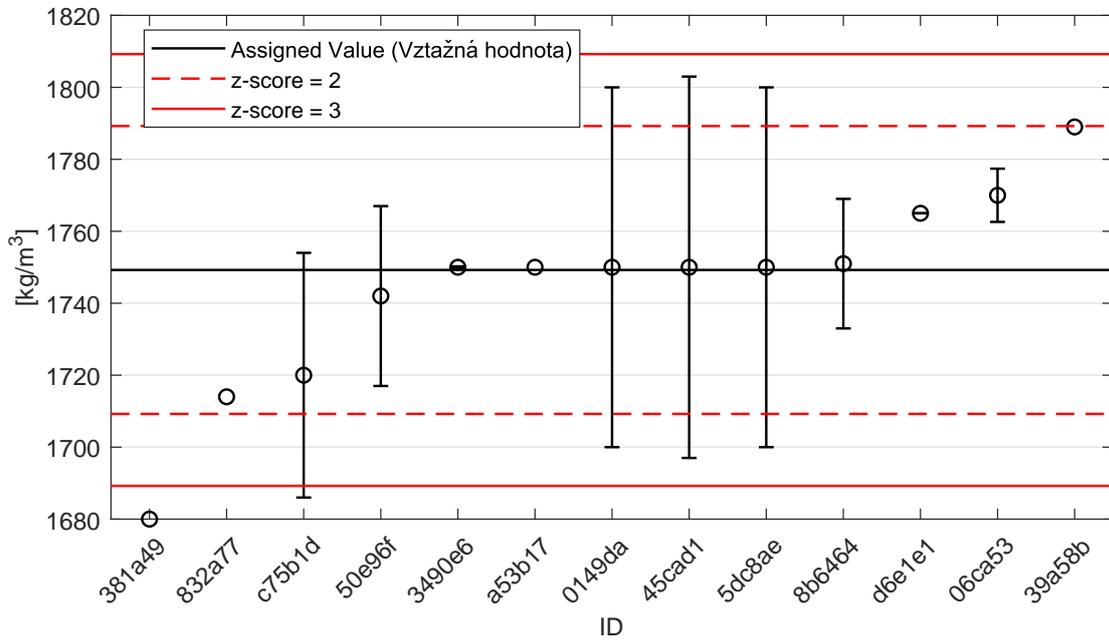
Figure 36: Average values and extended uncertainties of measurement
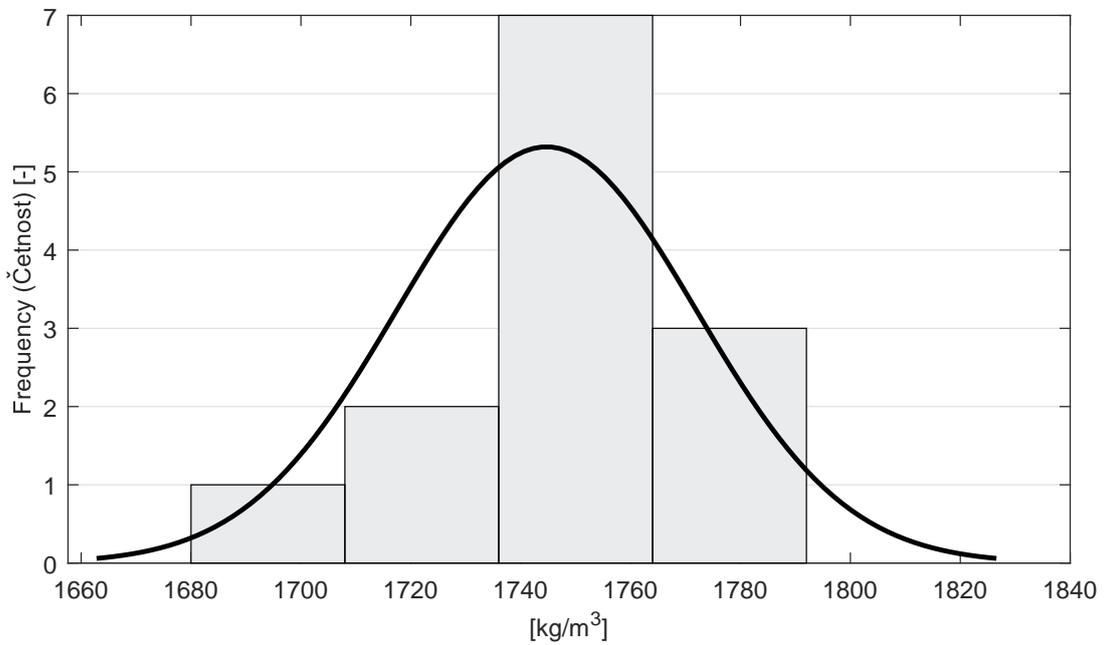
Figure 37: Histogram of all test results

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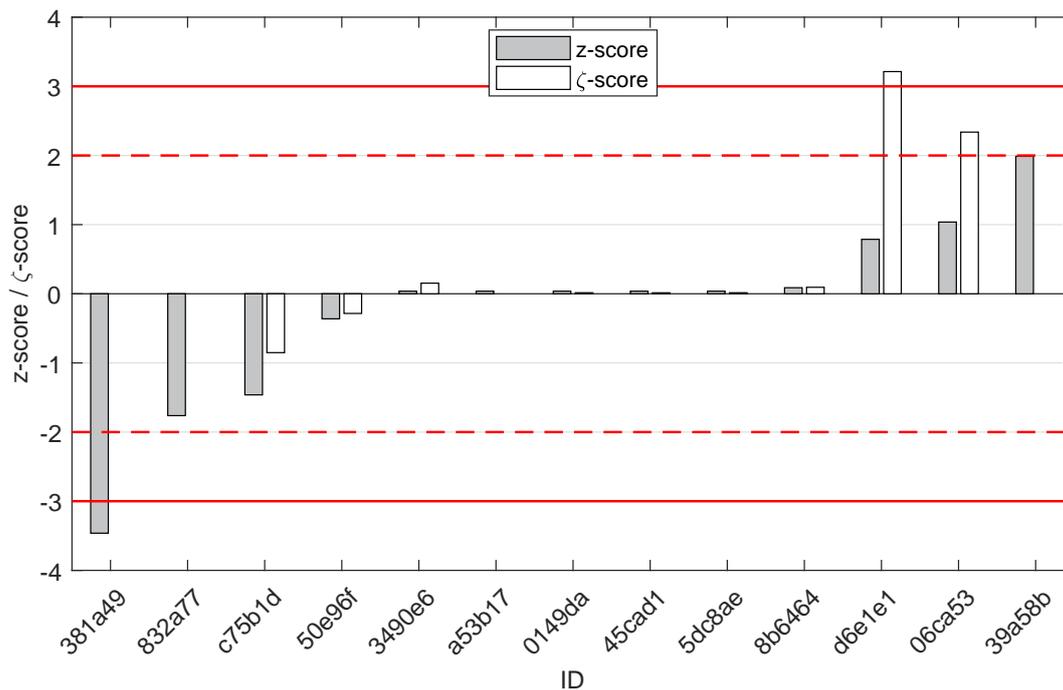
Figure 38: *z*-score

Table 15: *z*-score

ID	*z*-score [-]	ζ-score [-]
381a49	-3.46	-
832a77	-1.76	-
c75b1d	-1.46	-0.85
50e96f	-0.36	-0.28
3490e6	0.04	0.15
a53b17	0.04	-
0149da	0.04	0.01
45cad1	0.04	0.01
5dc8ae	0.04	0.01
8b6464	0.09	0.09
d6e1e1	0.79	3.21
06ca53	1.04	2.34
39a58b	1.99	-

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8.2 Optimum water content

8.2.1 Test results

Table 16: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [%]	u_X [%]
06ca53	13.0	0.4
381a49	13.7	-
39a58b	14.6	-
3490e6	15.7	0.2
45cad1	16.0	0.3
832a77	16.7	-
d6e1e1	16.7	0.5
8b6464	16.8	0.6
c75b1d	17.0	0.9
a53b17	17.0	-
0149da	17.0	2.0
50e96f	17.0	1.0
5dc8ae	17.5	0.5

8.2.2 The Numerical Procedure for Determining Outliers
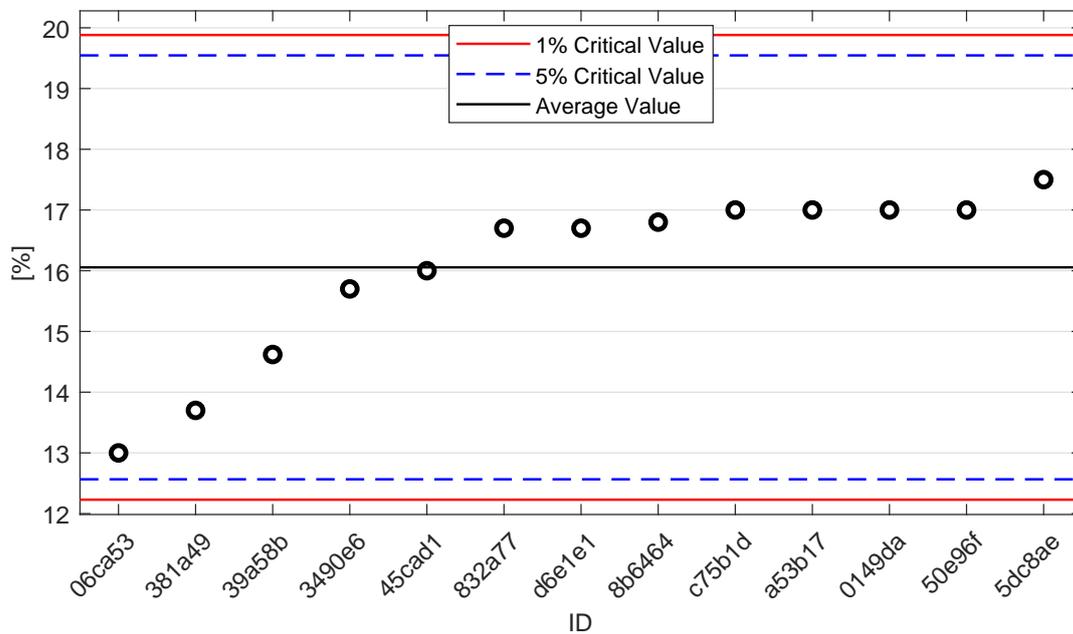
Figure 39: **Grubbs' test**: 1% critical value - red color; 5% critical value - blue color

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8.2.3   Mandel's Statistics
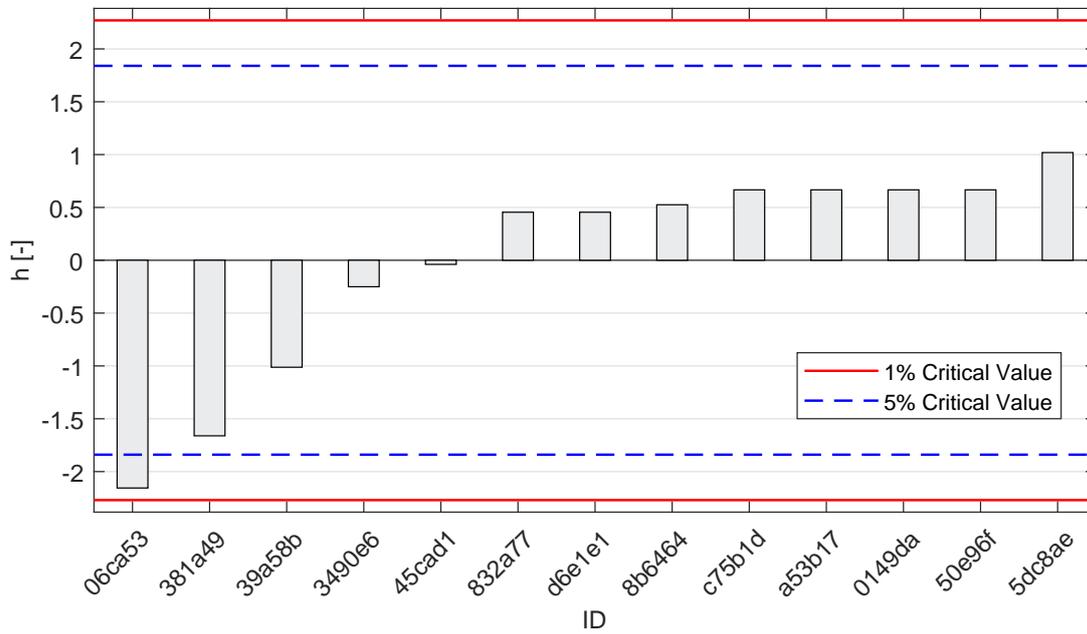
Figure 40: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

8.2.4   Calculation of Performance Statistics
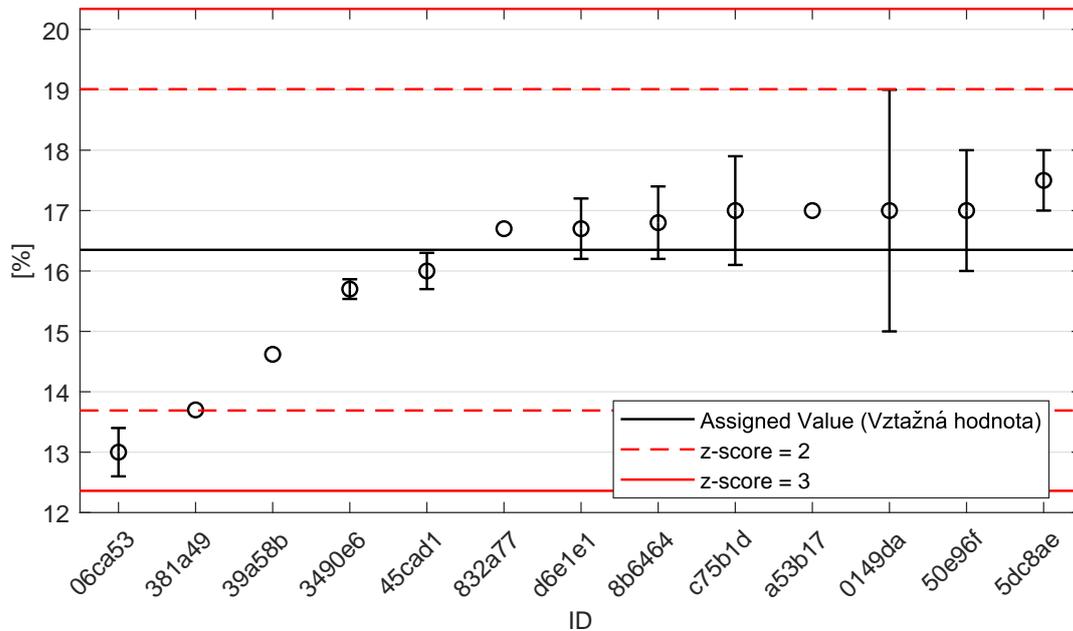
Figure 41: Average values and extended uncertainties of measurement

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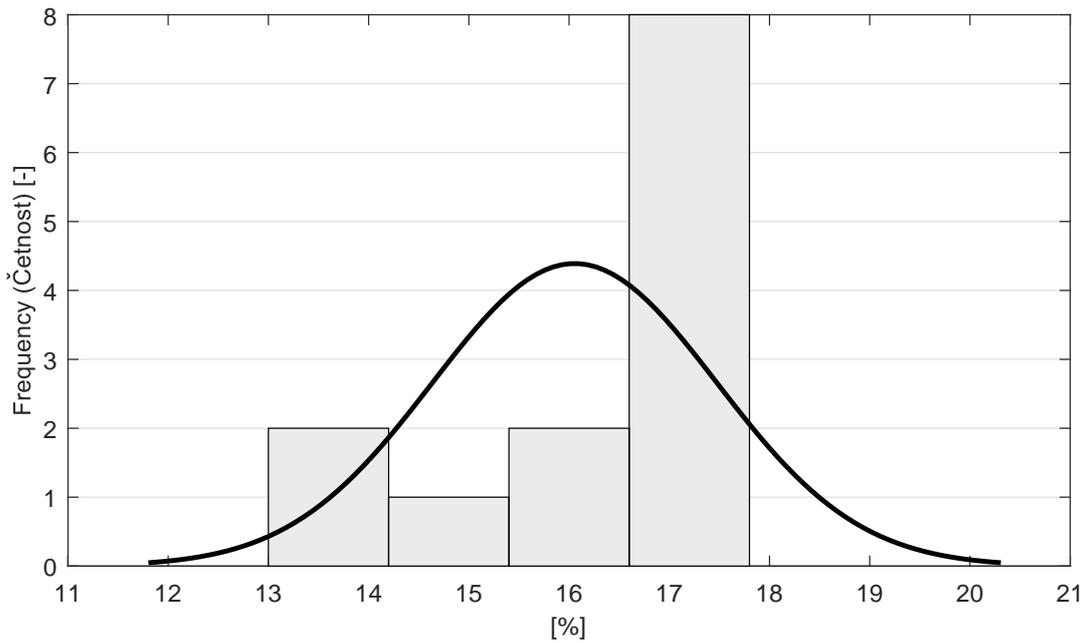
Figure 42: Histogram of all test results

Figure 43: z-score

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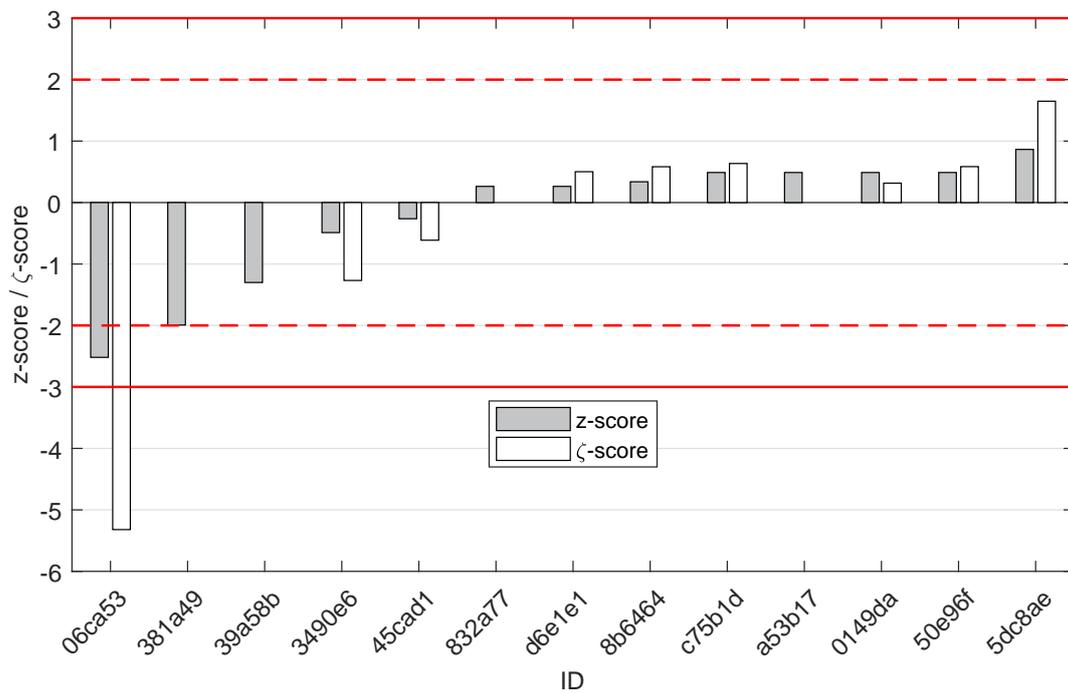
Table 17: z-score

ID	z-score [-]	ζ-score [-]
06ca53	-2.52	-5.32
381a49	-1.99	-
39a58b	-1.30	-
3490e6	-0.49	-1.27
45cad1	-0.26	-0.61
832a77	0.26	-
d6e1e1	0.26	0.50
8b6464	0.34	0.58
c75b1d	0.49	0.64
a53b17	0.49	-
0149da	0.49	0.32
50e96f	0.49	0.58
5dc8ae	0.86	1.65

9 Appendix – EN 13286-47 – CBR

9.1 Test results

Table 18: Test results - ordered. Outliers are marked by star. u_X - extended uncertainty of measurement;

ID of participant	Test results [%]	u_X [%]
ec1502	2	0
becf4a	13	-
832a77	17	-
6ad9ef	21	-
d3aa20	21	-
39a58b	21	-
b3a991	23	1
8d0790	25	-
50e96f	26	2
919bbf	27	2
06ca53	28	2
45cad1	31	1
3490e6	37	0

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## 9.2 The Numerical Procedure for Determining Outliers
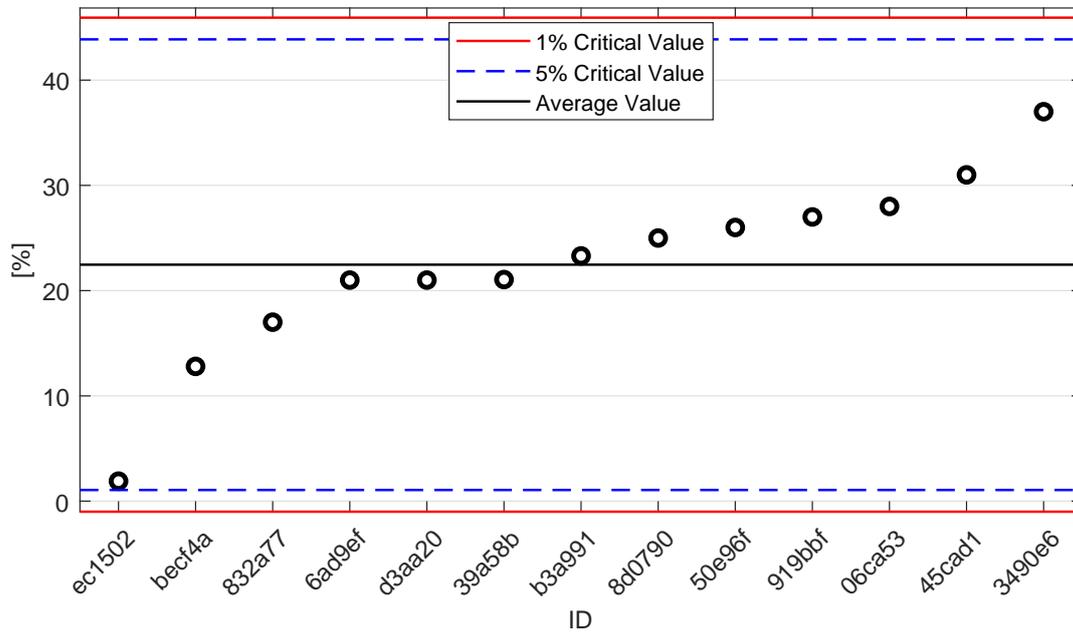
Figure 44: **Grubbs' test**: 1% critical value - red color; 5% critical value - blue color

9.3 Mandel's Statistics
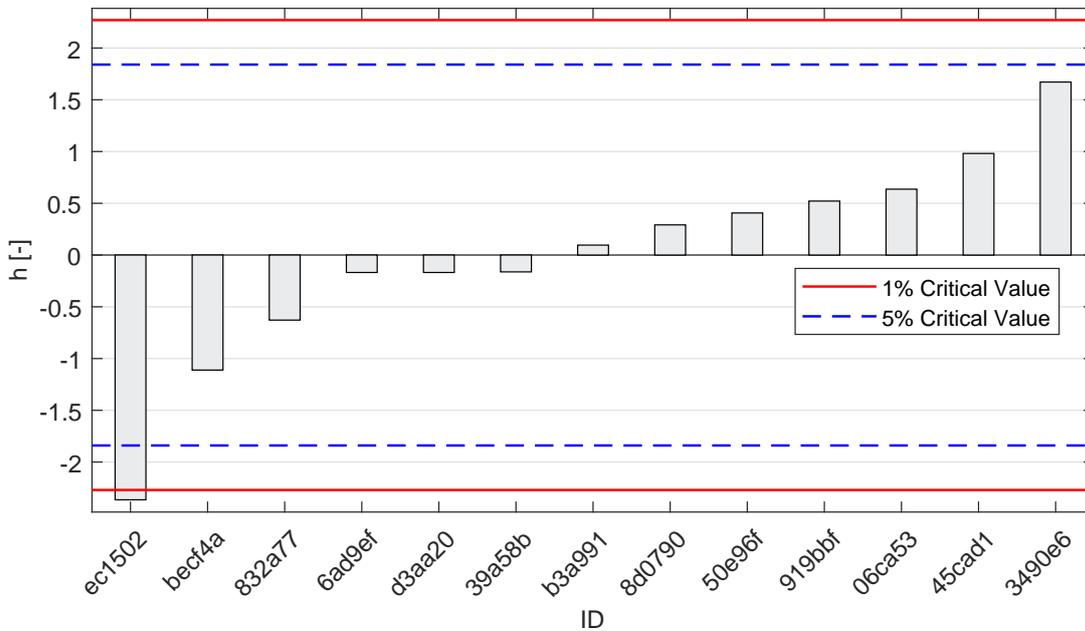
Figure 45: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

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9.4 Calculation of Performance Statistics
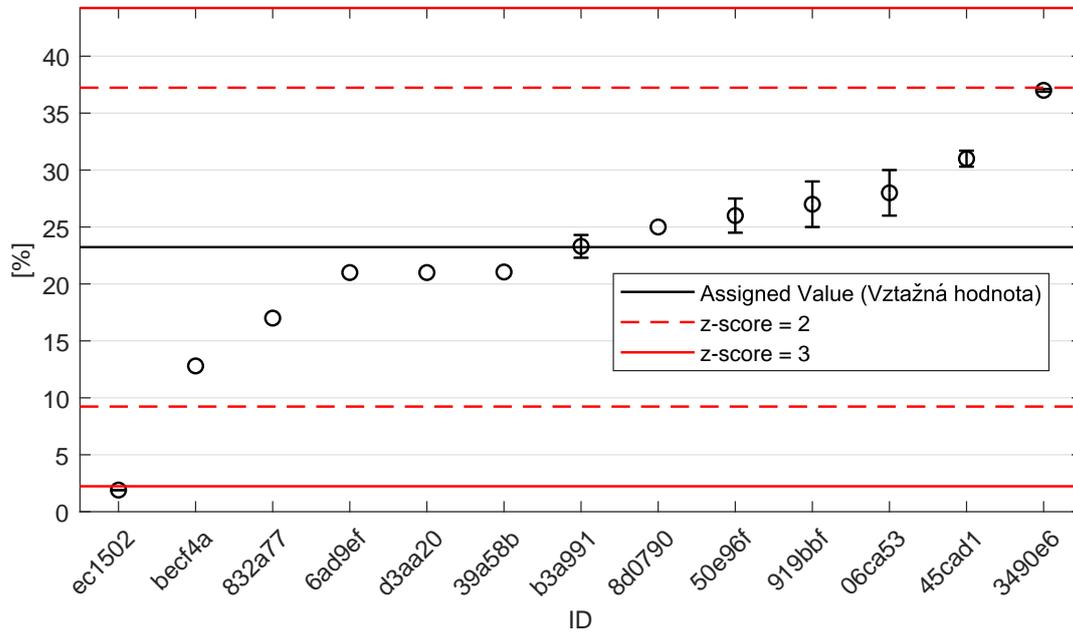
Figure 46: Average values and extended uncertainties of measurement
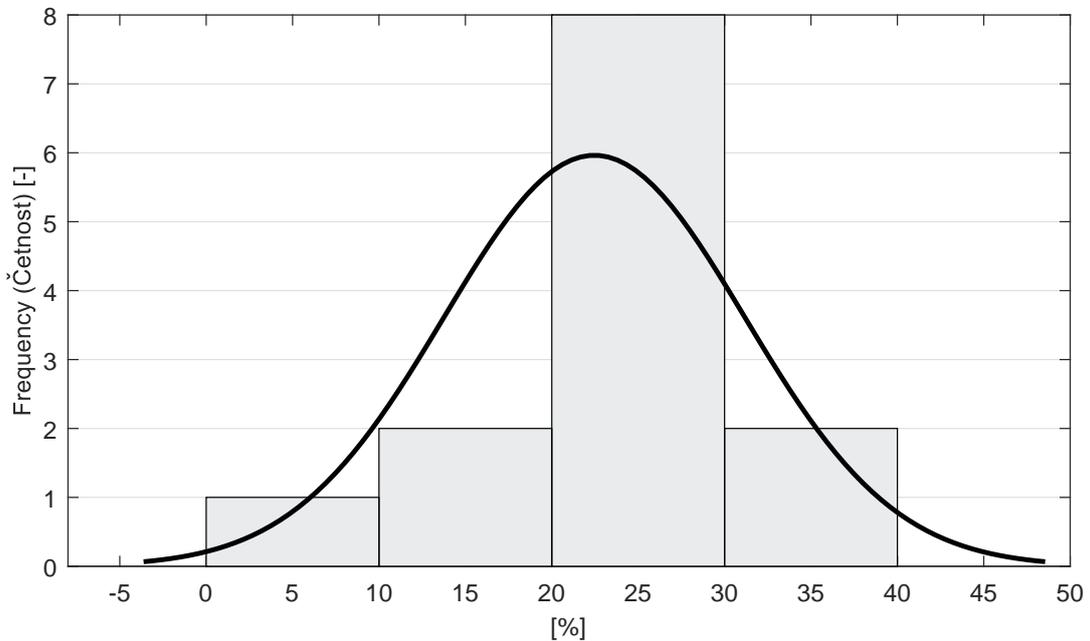
Figure 47: Histogram of all test results

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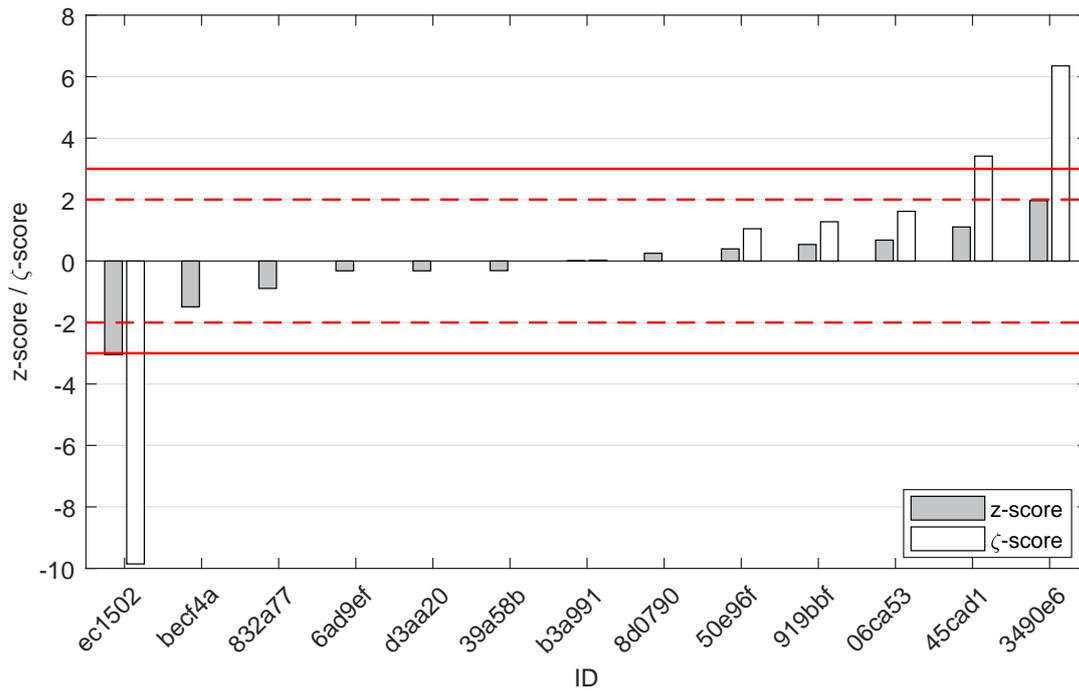
Figure 48: *z*-score

Table 19: *z*-score

ID	*z*-score [-]	ζ-score [-]
ec1502	-3.05	-9.86
becf4a	-1.49	-
832a77	-0.89	-
6ad9ef	-0.32	-
d3aa20	-0.32	-
39a58b	-0.31	-
b3a991	0.01	0.03
8d0790	0.25	-
50e96f	0.40	1.05
919bbf	0.54	1.28
06ca53	0.68	1.62
45cad1	1.11	3.41
3490e6	1.97	6.35

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