FINAL REPORT ON THE RESULTS OF PRECISION EXPERIMENT

PROFICIENCY TESTING PROGRAM
Mortar, Cement and Fine-grained Cement Composites

ZMC 2018/1

Brno University of Technology
Proficiency testing provider at the SZK FAST
Veveří 95, Brno 602 00
Czech Republic

www.szk.fce.vutbr.cz

Date: 01/14/2019

Assoc. Prof. Ing. Tomáš Vymazal, Ph.D.
Head of the PT Provider, PTP coordinator

Poskytovatel zkoušení
způsobilosti při SZK FAST
Proficiency testing
provider at the SZK FAST
Z 7008
Veveří 95
602 00 Brno   szk.fce.vutbr.cz
Czech Republic

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

Contents

CONTENTS

Proficiency Testing Provider at the SZK FAST | Z 7008   2/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Proficiency Testing Provider at the SZK FAST | Z 7008   3/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

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 ZMC 2018/1 whose aim was to verify and assess the conformity of test results across laboratories when testing mortar, cement and fine-grained cement composites.

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

Head of the PT Provider, PTP coordinator

Assoc. Prof. Ing. Tomáš Vymazal, Ph.D.
Brno University of Technology
Faculty of Civil Engineering
Institute of Building Testing
Veveří 95, Brno 602 00
Czech Republic
Tel.: +420 603 313 337
Email: Tomas.Vymazal@vutbr.cz

Coordinator of PTP result assessment PrZZ

Ing. Petr Misák, Ph.D.
Brno University of Technology
Faculty of Civil Engineering
Institute of Building Testing
Veveří 95, Brno 602 00
Czech Republic
Tel.: +420 774 980 255
Email: Petr.Misak@vutbr.cz

The subjects of proficiency testing were the following testing procedures:

1. **EN 196-1 – Strength** [1]

2. **EN 196-2 (art. 7) – Determination of loss on ignition** [2]

3. **EN 196-2 (art. 8) – Determination of sulphate content** [2]

4. **EN 196-2 (art. 9) – Remainder determination** [2]

5. **EN 196-2 (art. 10) – Remainder determination** [2]

6. **EN 196-2 (art. 11) – Determination of sulphite content** [2]

7. **EN 196-3 – Setting time, Volume weight** [3]

8. **EN 196-10 – Determination of the water-soluble chromium (Cr^{6+})** [4]

9. **EN 1015-1 – Granularity** [5]

10. **EN 1015-3 – Consistency** [6]

11. **EN 1015-6 – Volume Weight** [7]

12. **EN 1015-10 – Volume Weight** [8]

13. **EN 1015-11 – Strength** [9]

14. **EN 1015-12 – Adhesion** [10]

15. **EN 1015-18 – Capillary absorption coeff. (C_m)** [11]

16. **EN 1015-19 – Water vapor flow** [12]

17. **EN 13892-2 – Tensile strength when bent and compressed** [13]

18. **EN 12004-2, (art. 8.1) – Open time** [14]

19. **EN 12004-2, (art. 8.2) – Slippage** [14]

Proficiency Testing Provider at the SZK FAST | Z 7008   4/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

1. INTRODUCTION AND IMPORTANT CONTACTS

Testing procedures No 1, 13, 17 and 19 were open. The other methods were not been open due to lack of participants.

The specimens were taken from the same production with the same production date. The test results from individual PTP participants were compared via a method involving the statistical analysis of all their results in a manner complying with ISO 5725-2 [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.

22 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 (tests designated according to part 1)

ID/Part	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0fa3f4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
2e9492	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
3941ae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
47eabe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
502fd5	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
5370ea	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
541e45	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
576ad3	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
5e9081	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6ef3e3	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-
81b7ec	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
8cbdf5	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
a4e72b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
bf5a4f	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
c29e7e	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
c9cb0d	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
eab579	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
eb4d30	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
ed272b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
f099ab	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
f2bf72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X
f56ca2	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-
n	8	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	6	0	5

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
BETONTEST, spol. s r. o.	Trnkova 3083/162, Brno, 62800, Česká republika	1116
BETOTECH, s.r.o.	Beroun 660, Beroun, 26601, Česká republika	1195
Cement Hranice, akciová společnost - Betonářská laboratoř	Bělotínská 288, Hranice I - Město, 75301, Česká republika	1284
CEMEX Czech Republic, s.r.o.	Semtín 102, Pardubice, 53354, Česká republika	1302

Proficiency Testing Provider at the SZK FAST | Z 7008   5/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Laboratory	Address	Accreditation number
Centrum stavebního inženýrství a.s.	K Cihelně 304, Zlín - Louky, 764 32, Česká republika	1007.1
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.	Pf. 180., Szentendre, 2001, Hungary	NAH-1-1110/2018
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.	Dózsa György út 26., Szentendre, 2000, Hungary	NAH-1-1110/2018
ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.	Pf. 180., Szentendre, 2000, Hungary	NAH-1-1110/2018
Ivanka Dobreva	kompl."Mladost-1" bl.43/vh.3/floor 5/ ap.41, Sofia, 1784, Bulgaria	71
LABBET - Betosan s.r.o.	Nová cesta 40/291, Praha 4, 14000, Česká republika	1687
LI "Zemna mehanika" - Baugrund Institut Knirim OOD	3 Tsarevo selo Str., atelie-parter, Sofia, 1612, Bulgaria	255LI
Lithuanian Energy Institute	Breslaujos str. 3, Kaunas, LT 44403, Lithuania	LA.01.006
PI Institute for Urbanism, Civil Engineering and Ecology of Republic of Srpska	Save Mrkalja 16, Banja Luka, 78000, BiH	LI-79-01
QUALIFORM SLOVAKIA s.r.o. , Pracovisko 01 Bratislava	Pasienková 9 D, Bratislava, 82106, Slovenská republika	154/S-301
Ředitelství silnic a dálnic ČR	Rebešovická 40, Brno-Chrlice, 643 00, Česká republika	1072
SQZ, s.r.o.	U místní dráhy 939/5, Olomouc, Nová ulice, 779 00, Česká republika	1135.2
STACHEMA CZ s.r.o., Zkušební laboratoř, Pracoviště 2	Hasičská 1, Zibohlavy, Kolín, 280 02, Česká republika	L 1433
Technische Universität Graz - TVFA	Inffeldgasse 24, Graz, 8010, Austria	
TPA EO D, CTC SOFIA	Rezbarska 7 str., Sofia, 1510, Bulgaria	
Ústav stavebního zkušebnictví s.r.o.	Jiřího Potůčka 115, Pardubice, 53009, Česká republika	1115
Vysoké učení technické v Brně, Fakulta stavební, Akreditovaná zkušební laboratoř při ÚTHD FAST VUT v Brně	Veveří 331/95, Brno, 6022, Česká republika	L1396
ŽPSV a. s.	Třebízského 207, Uherský Ostroh, 68724, Česká republika	1041

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 ZMC 2018/1 (PT Program) organized by the PT Provider at the SZK FAST, Brno University of Technology. 22 participants (laboratories) took part in the PT Program. The program focused on ordinary standardized testing of mortar, cement, fine-grained cement composites. The test results are evaluated separately for each testing procedure examined. An evaluation of statistical characteristics is included in the Appendix, as well as test results and graphical 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

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

6/67

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 196-1 – Strength

Two characteristics were measured – flexural strength and compressive strength in 2, 7 and 28 days of ageing. These characteristics were evaluated separately. The results were assessed as outlying, questionable and unsatisfactory in case of two appropriate levels at least. The test results are shown together with graphical presentation and evaluated statistical characteristics in part 1 of the Appendix.

The numerical critical evaluation of the test results did not show any exceedence of critical values. Graphical determination of the consistency of laboratories (Mandel's statistics) has shown an exceedance of the critical value in the test results. 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. None of the participants were therefore excluded.

The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [17]). The results of all participants did not exceed the limit value of z-score $= 2$ in case of two appropriate levels at least and thus can be rated as **satisfactory**.

3.2   EN 196-2 (Chapter 7) – Determination of loss on ignition

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

3.3   EN 196-2 (Chapter 8) – Determination of sulphate content

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

3.4   EN 196-2 (Chapter 9) – Remainder determination

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

3.5   EN 196-2 (Chapter 10) – Remainder determination

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

3.6   EN 196-2 (Chapter 11) – Determination of sulphite content

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

3.7   EN 196-3 – Setting time, Volume weight

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

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

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

3.9   EN 1015-1 – Granularity

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

3.10   EN 1015-3 – Consistency

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

Proficiency Testing Provider at the SZK FAST | Z 7008   7/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

3.11   EN 1015-6 – Volume Weight

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

3.12   EN 1015-10 – Volume Weight

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

3.13   EN 1015-11 – Strength

Two characteristics were measured – flexural strength and compressive strength. These characteristics were evaluated separately. The test results are shown together with graphical presentation and evaluated statistical characteristics in part 13 of the Appendix.

The numerical critical evaluation of the test results using Cochran's and Grubbs' test has shown that results of participant **eab579** exceeded the 1% critical values. These test results were assigned as **outlying** and were excluded from the experiment. After its removal the critical values were no longer exceeded.

Graphical determination of the consistency of laboratories (Mandel's statistics) has shown an exceedance of the critical value in the test results. 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.

The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [17]). The results of all non outlying participants did not exceed the limit value of z-score $= 2$ and thus can be rated as **satisfactory**.

3.14   EN 1015-12 – Adhesion

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

3.15   EN 1015-18 – Capillary absorption coeff. (C_m)

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

3.16   EN 1015-19 – Water vapor flow

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

3.17   EN 13892-2 – Tensile strength when bent and compressed

Two characteristics were measured – flexural strength and compressive strength. These characteristics were evaluated separately. The test results are shown together with graphical presentation and evaluated statistical characteristics in part 17 of the Appendix.The numerical and graphical critical evaluation did not indicate any exceedance of critical values.

The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [17]). The results of all participants did not exceed the limit value of z-score $= 2$ in case of two appropriate levels at least and thus can be rated as **satisfactory**.

3.18   EN 12004-2, (art. 8.1) – Open time

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

3.19   EN 12004-2, (art. 8.2) – Slippage

The test results are shown together with graphical presentation and evaluated statistical characteristics in part 19 of the Appendix.

The numerical critical evaluation of the test results using Cochran's test has shown that results of participant a4e72b exceeded the 1% critical value. A more detailed analysis has revealed that the outlying variability was caused by one test result only; after its removal the critical values of Cochran's test were no longer exceeded. None of the participants were therefore excluded.

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

8/67

The assigned value and its uncertainty was determined using the A algorithm (ISO 13258 [17]). 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**.

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

9/67

References

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

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

[3] EN 196-3. *Methods of testing cement - Part 3: Determination of setting times and soundness*. 2009.

[4] EN 196-10. *Methods of testing cement - Part 10: Determination of the water-soluble chromium (VI) content of cement*. 2006.

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

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

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

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

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

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

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

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

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

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

[15] ISO 5725-2. *Accuracy (trueness and precision) of measurement methods and results - Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*. 1997.

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

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

Proficiency Testing Provider at the SZK FAST | Z 7008   10/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

1 Appendix – EN 196-1 – Strength

1.1 Flexural Strength after 2 days of ageing

1.1.1 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

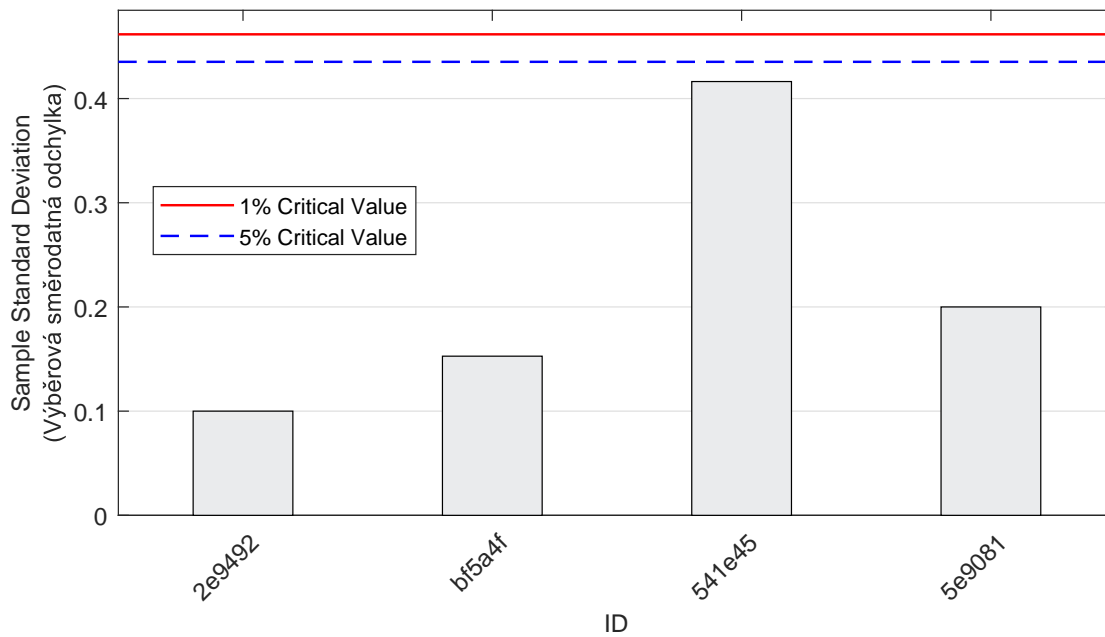| ID of participant	Test results [N/mm^2]			u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
2e9492	5.5	5.4	5.3	0.2	5.4	0.1	1.85
bf5a4f	5.6	5.5	5.3	0.1	5.5	0.2	2.79
541e45	5.8	5.2	6.0	0.2	5.7	0.4	7.35
5e9081	6.0	5.6	5.8	-	5.8	0.2	3.45

1.1.2 The Numerical Procedure for Determining Outliers

Figure 1: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
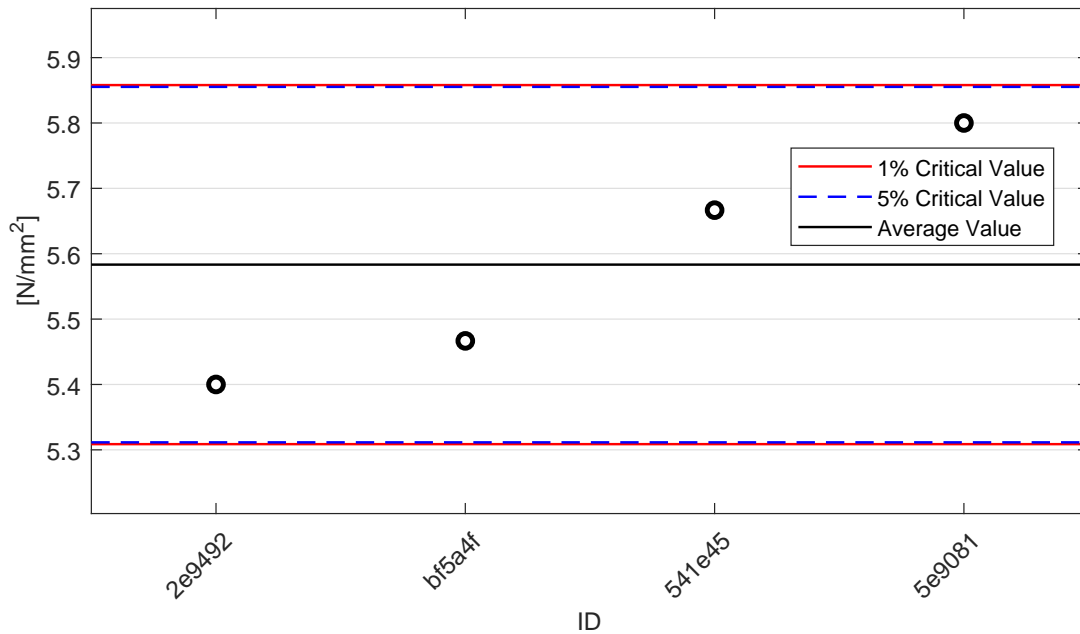
Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

11/67

Figure 2: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color
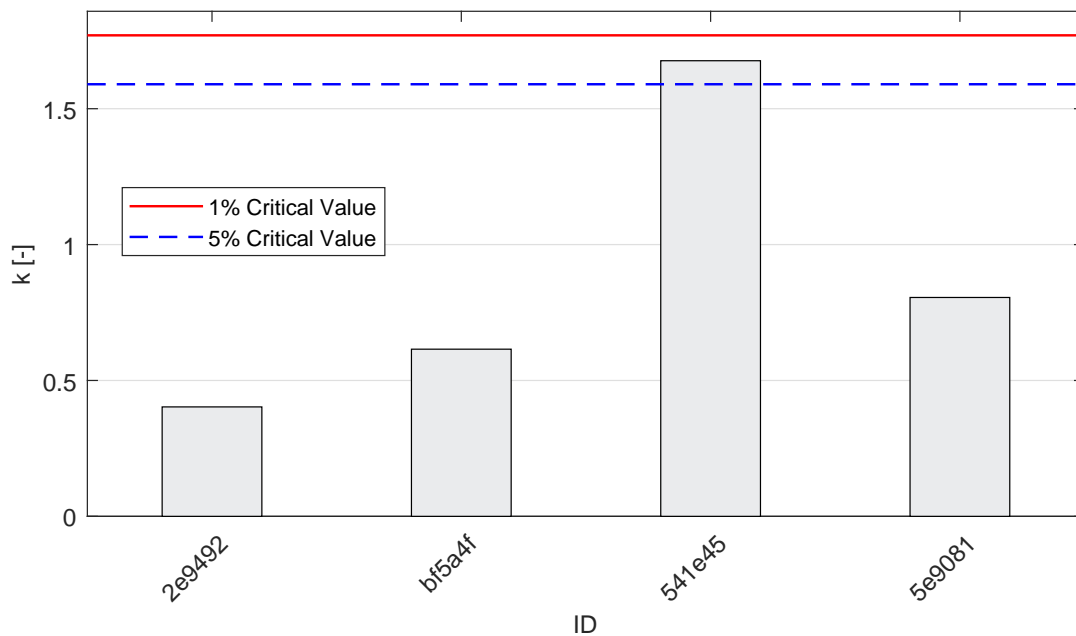
1.1.3 Mandel's Statistics

Figure 3: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   12/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
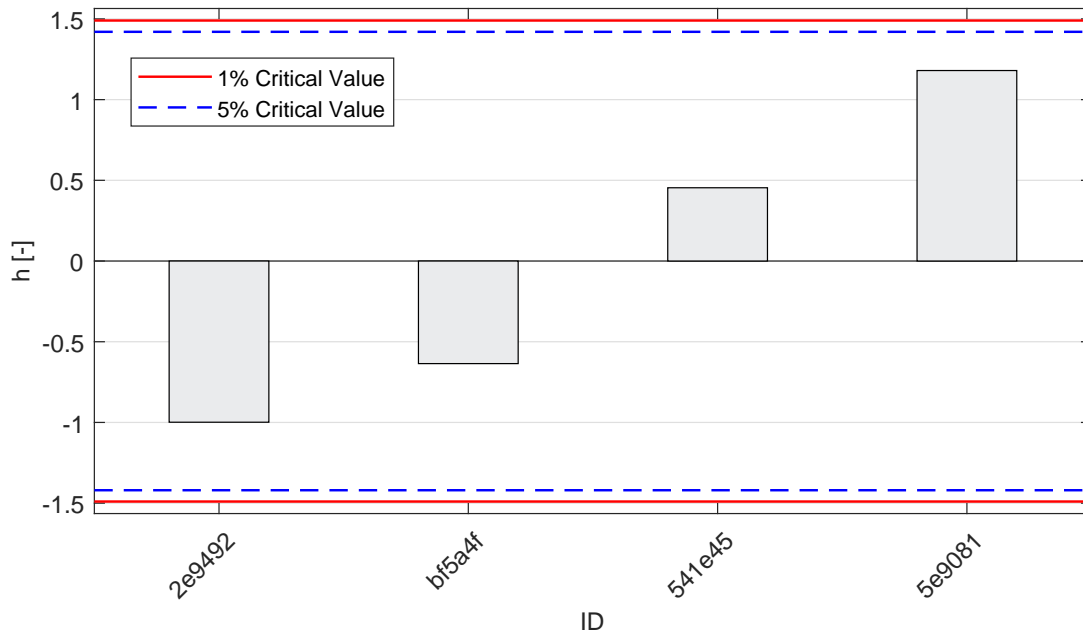szk.fce.vutbr.cz | ptprovider.cz

Figure 4: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

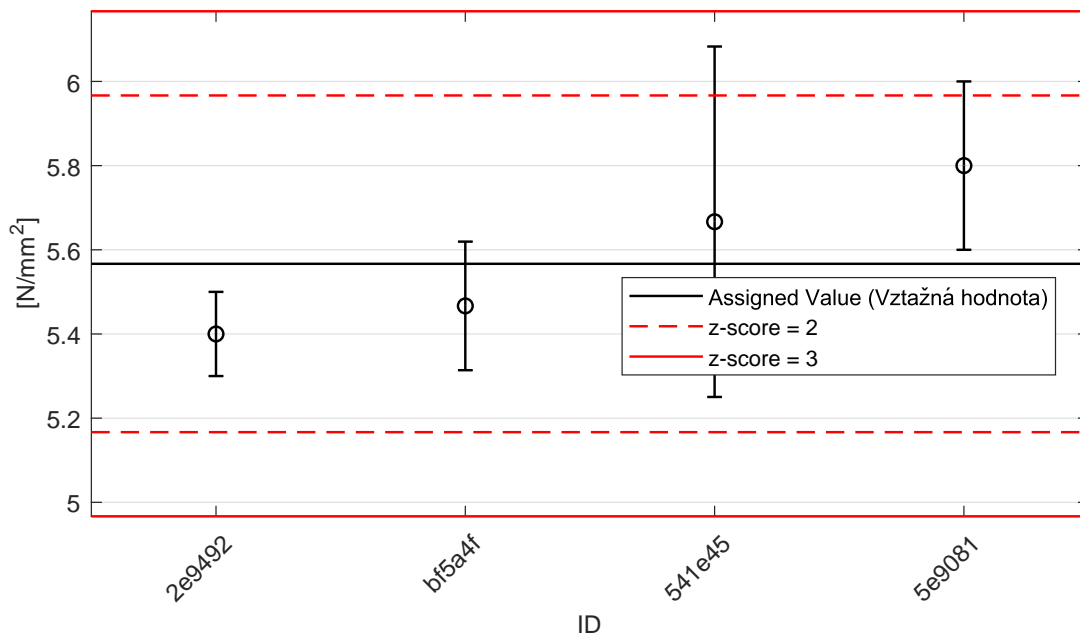### 1.1.4 Calculation of Performance Statistics

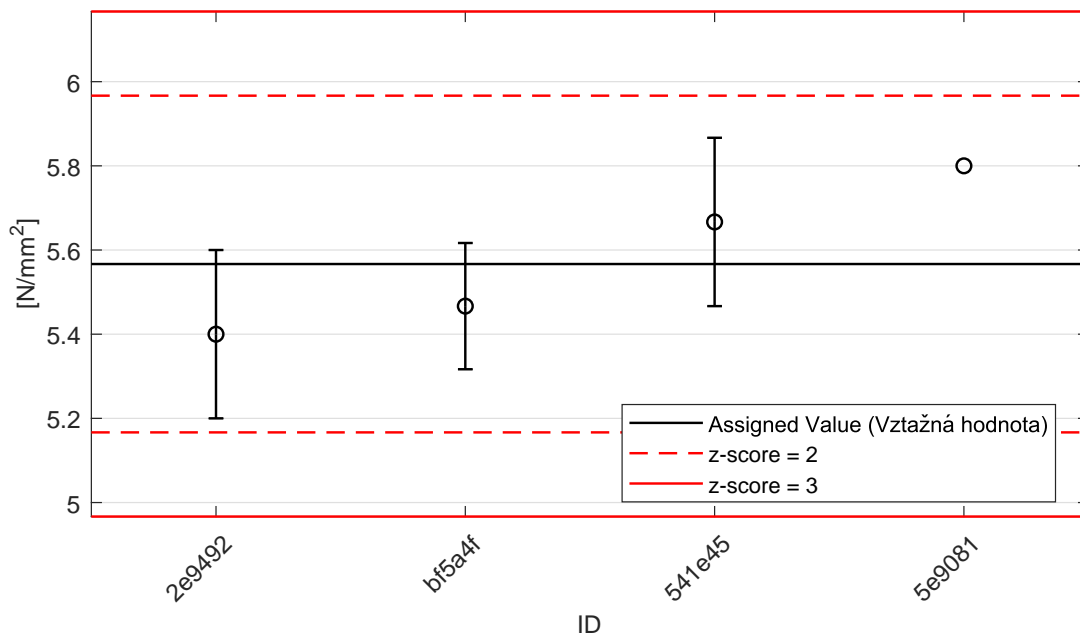Figure 5: Average values and sample standard deviations

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

13/67

Figure 6: Average values and extended uncertainties of measurement

Figure 7: Histogram of all test results

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

14/67

Figure 8: z-score and ζ-score

Table 4: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
2e9492	-0.83	-0.73
bf5a4f	-0.50	-0.54
541e45	0.50	0.44
5e9081	1.17	-

1.2 Flexural Strength after 7 days of ageing

1.2.1 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 [N/mm^2]			u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
541e45	7.1	7.6	7.3	0.3	7.3	0.3	3.43
5e9081	7.6	7.4	7.3	-	7.4	0.2	2.05
bf5a4f	7.9	7.5	7.8	0.2	7.7	0.2	2.69
2e9492	8.4	8.5	8.0	0.3	8.3	0.3	3.19

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

15/67

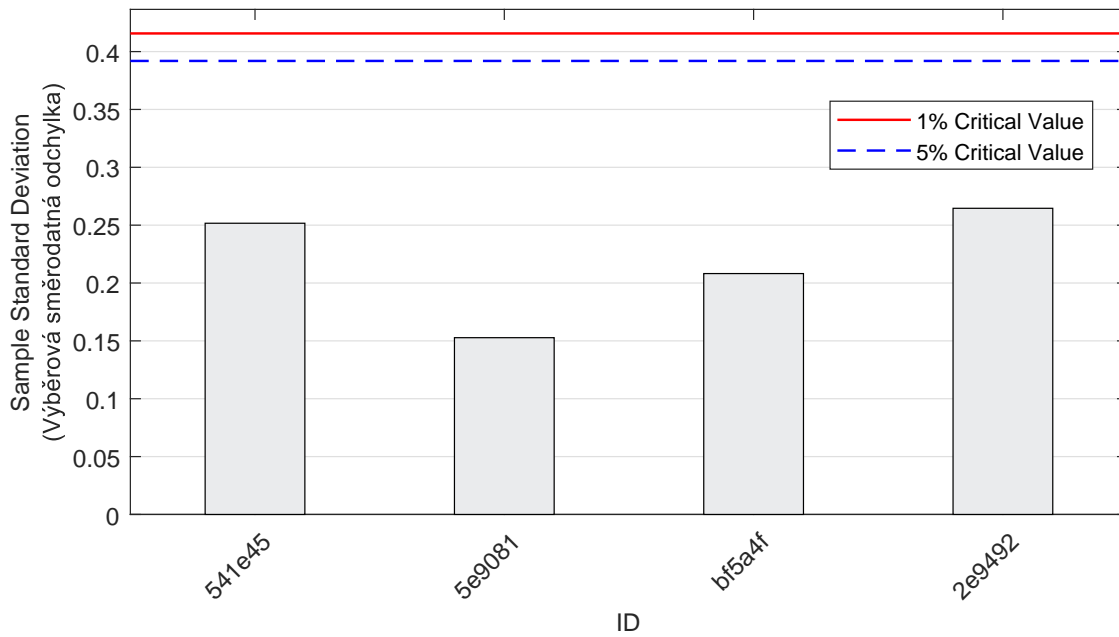### 1.2.2   The Numerical Procedure for Determining Outliers

Figure 9: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
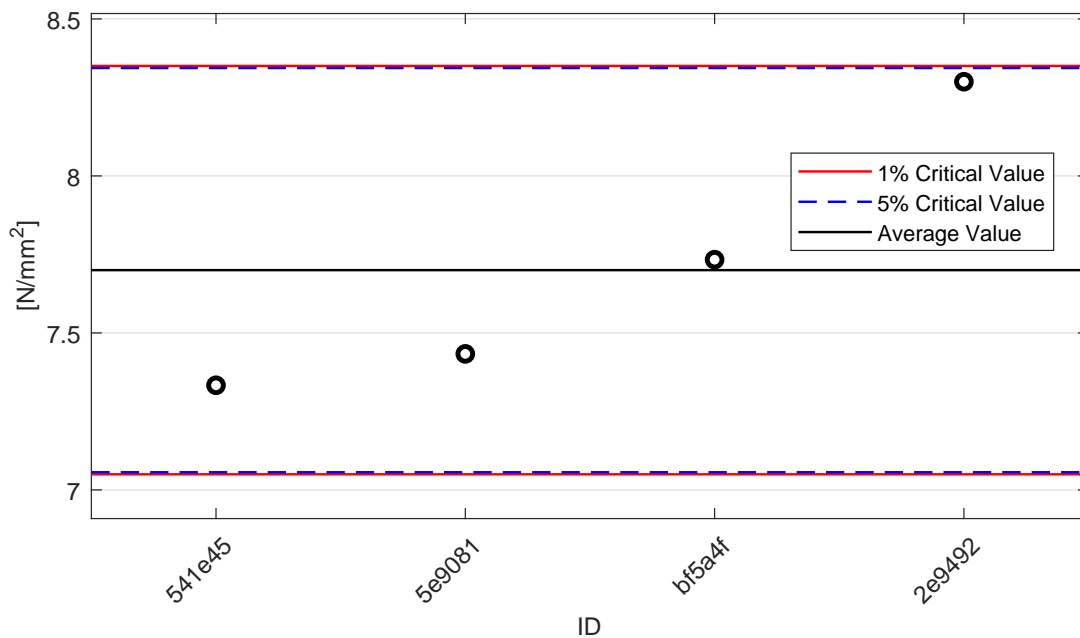

Figure 10: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   16/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz
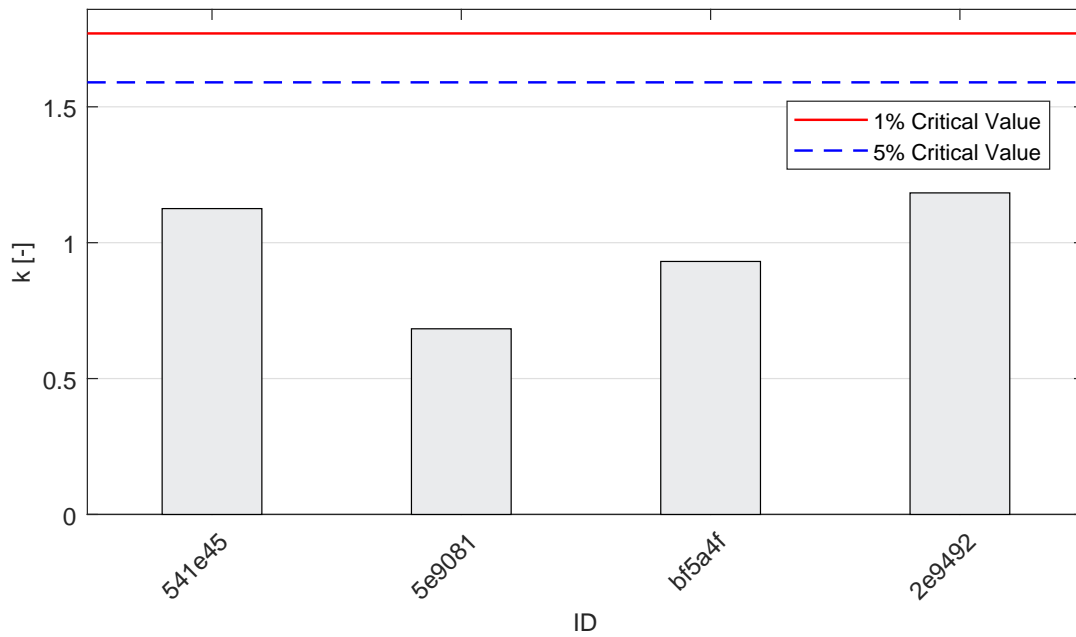
1.2.3 Mandel's Statistics

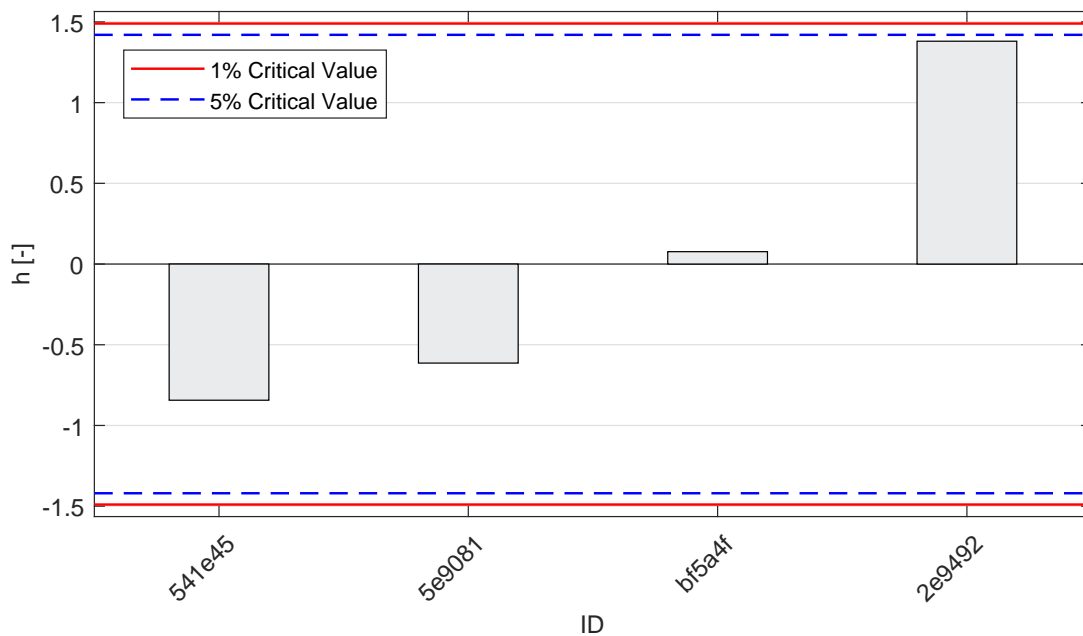Figure 11: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Figure 12: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

17/67

1.2.4 Calculation of Performance Statistics
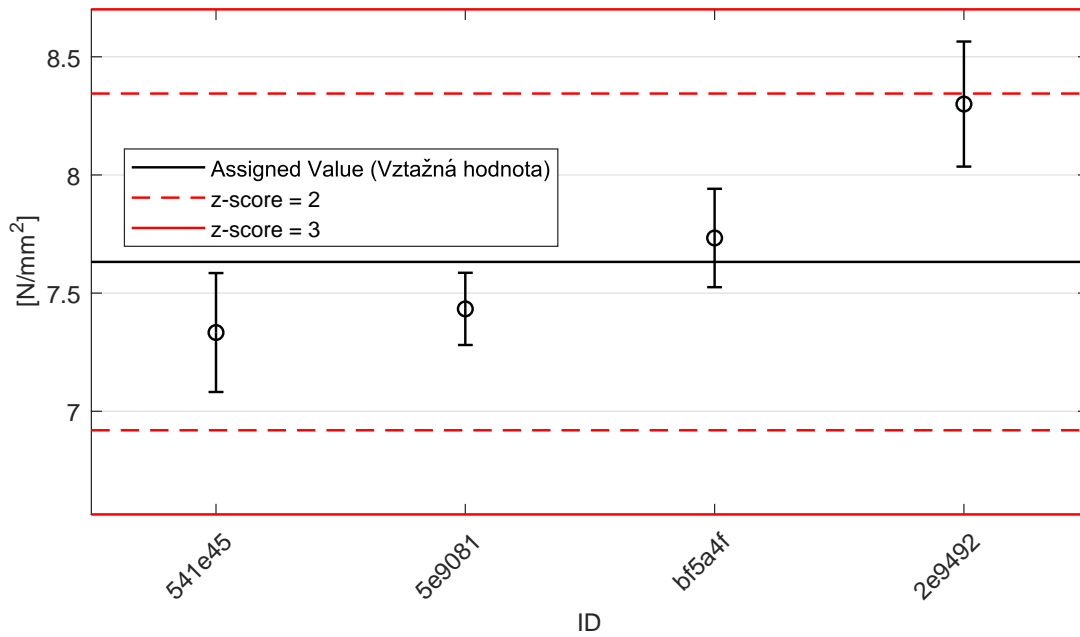

Figure 13: Average values and sample standard deviations

Figure 14: Average values and extended uncertainties of measurement
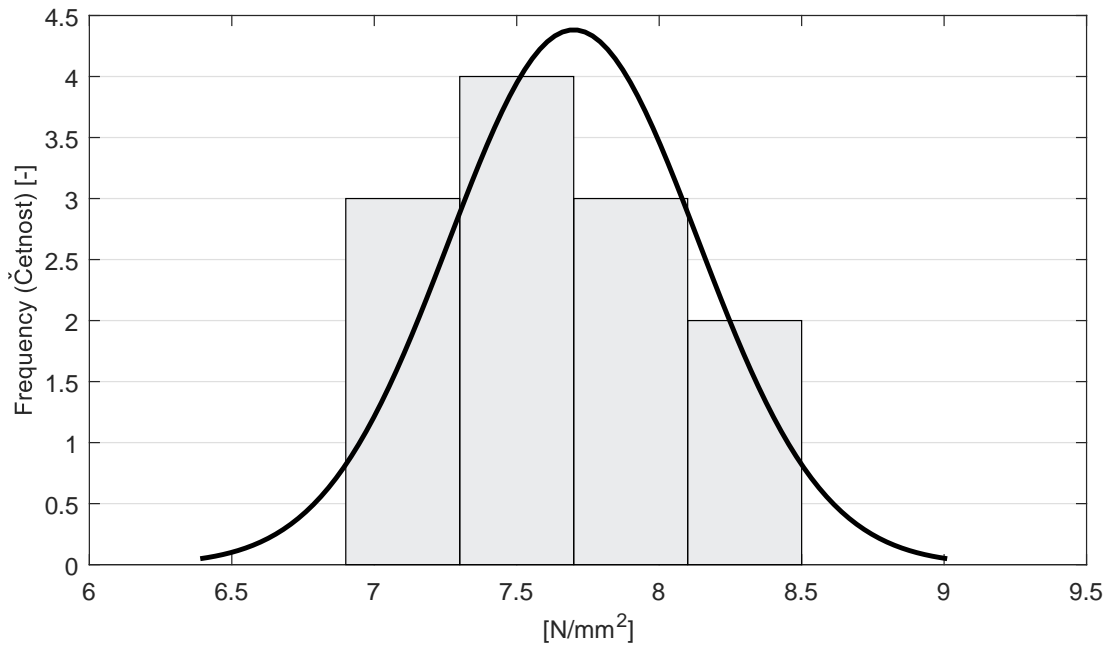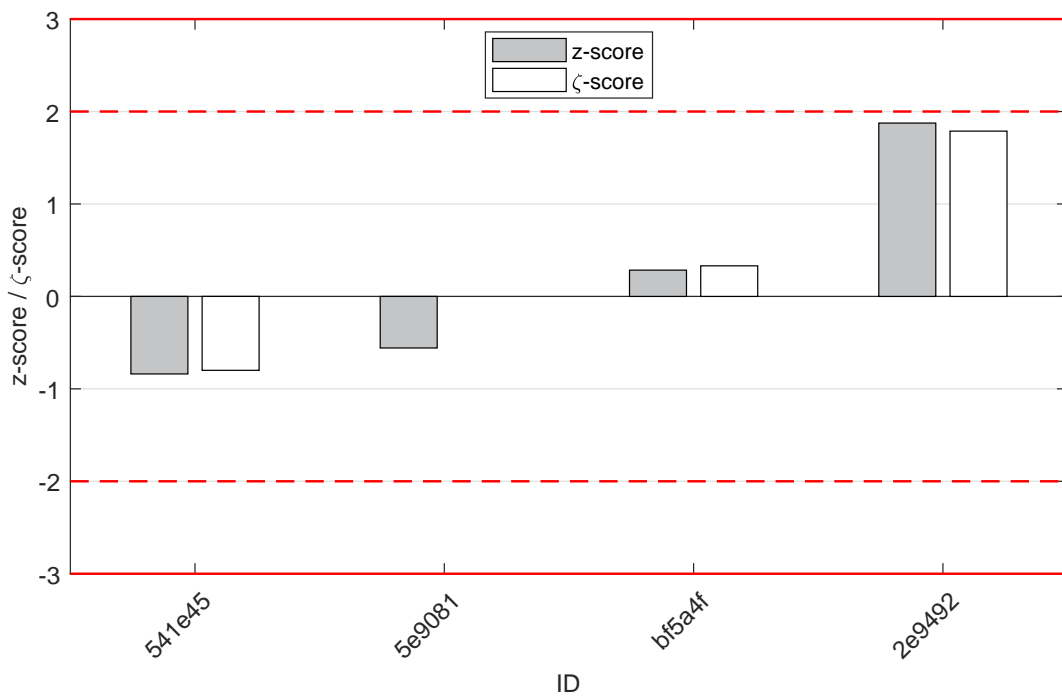
Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

18/67

Figure 15: Histogram of all test results

Figure 16: z-score and ζ-score

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

19/67

Table 6: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
541e45	-0.84	-0.80
5e9081	-0.56	-
bf5a4f	0.28	0.33
2e9492	1.88	1.79

1.3 Flexural Strength after 28 days of ageing

1.3.1 Test results

Table 7: 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

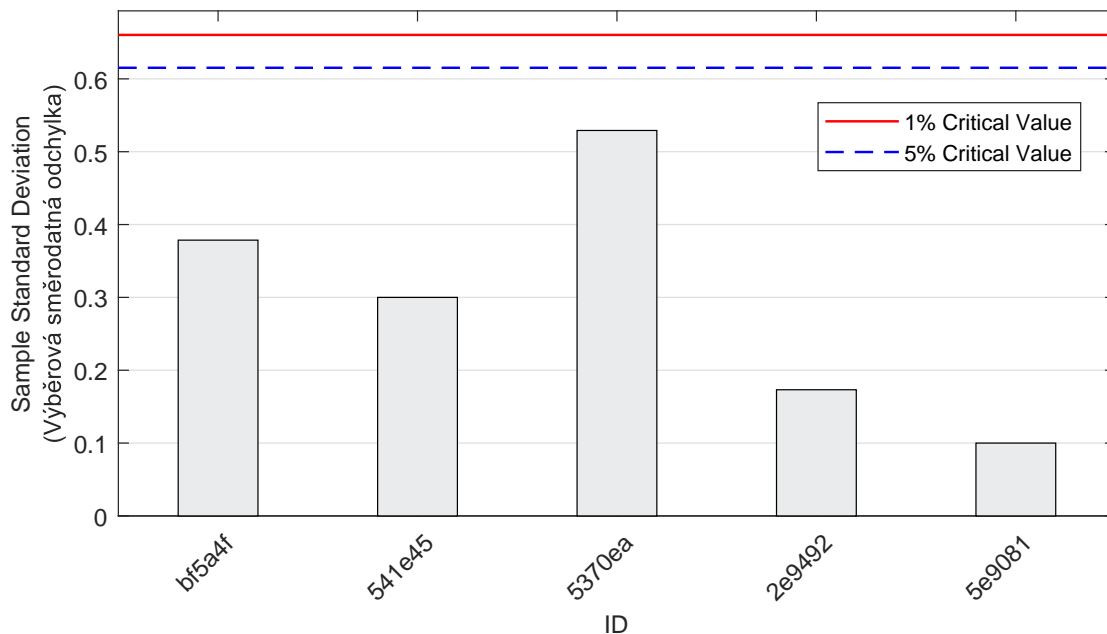| ID of participant	Test results [N/mm^2]			u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
bf5a4f	7.7	7.6	8.3	0.4	7.9	0.4	4.81
541e45	7.9	7.6	8.2	0.3	7.9	0.3	3.80
5370ea	8.5	9.5	8.7	0.7	8.9	0.5	5.95
2e9492	9.0	8.7	9.0	0.3	8.9	0.2	1.95
5e9081	8.8	9.0	8.9	0.3	8.9	0.1	1.12

1.3.2 The Numerical Procedure for Determining Outliers

Figure 17: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
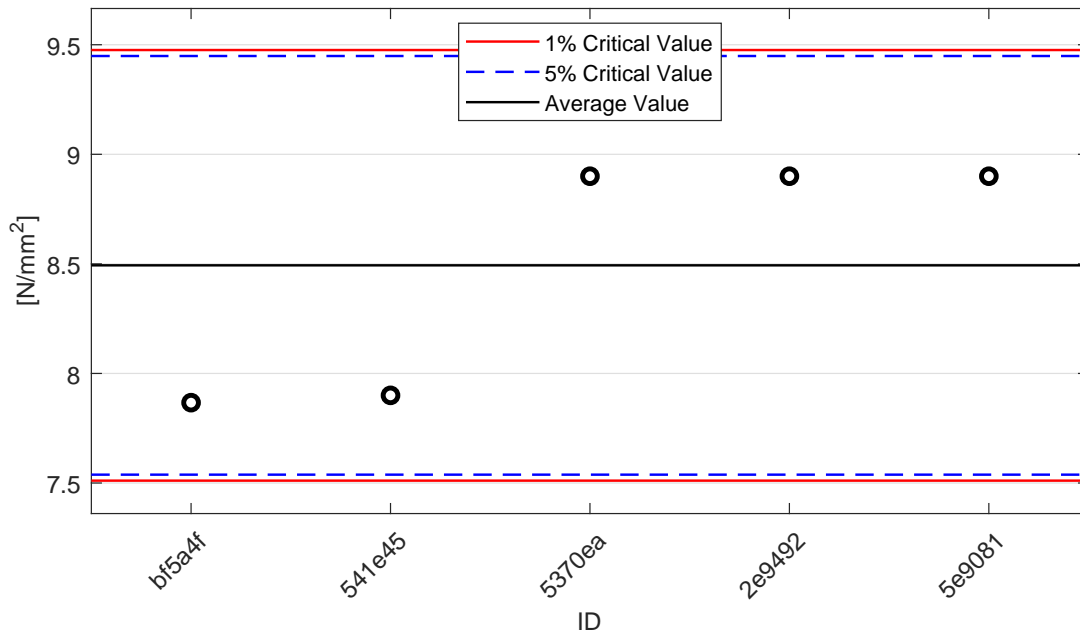szk.fce.vutbr.cz | ptprovider.cz

20/67

Figure 18: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color
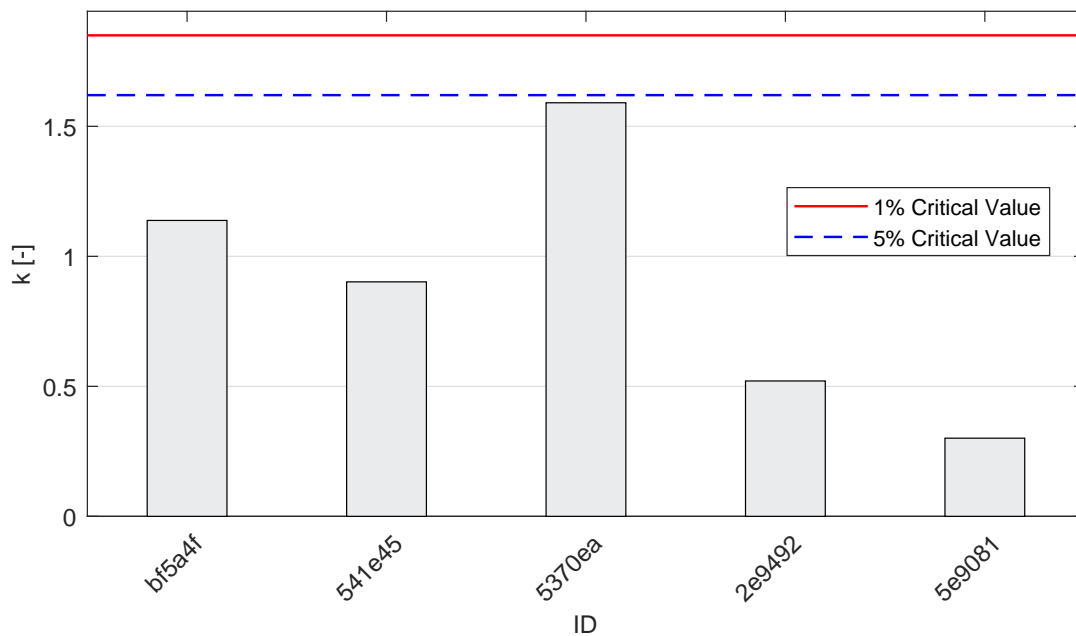
1.3.3 Mandel's Statistics

Figure 19: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   21/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
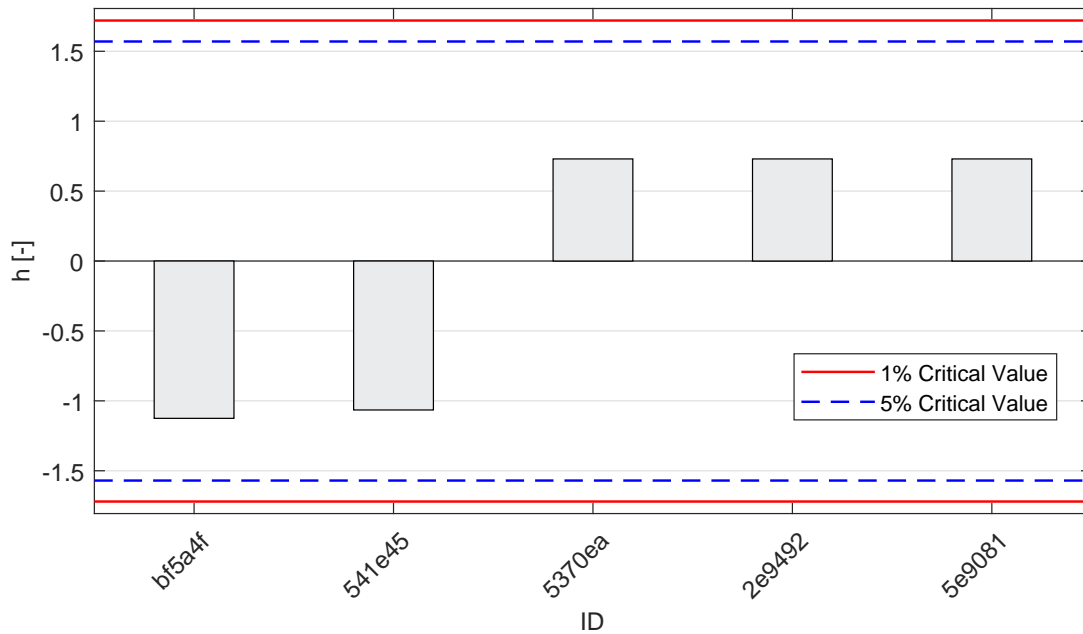Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Figure 20: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

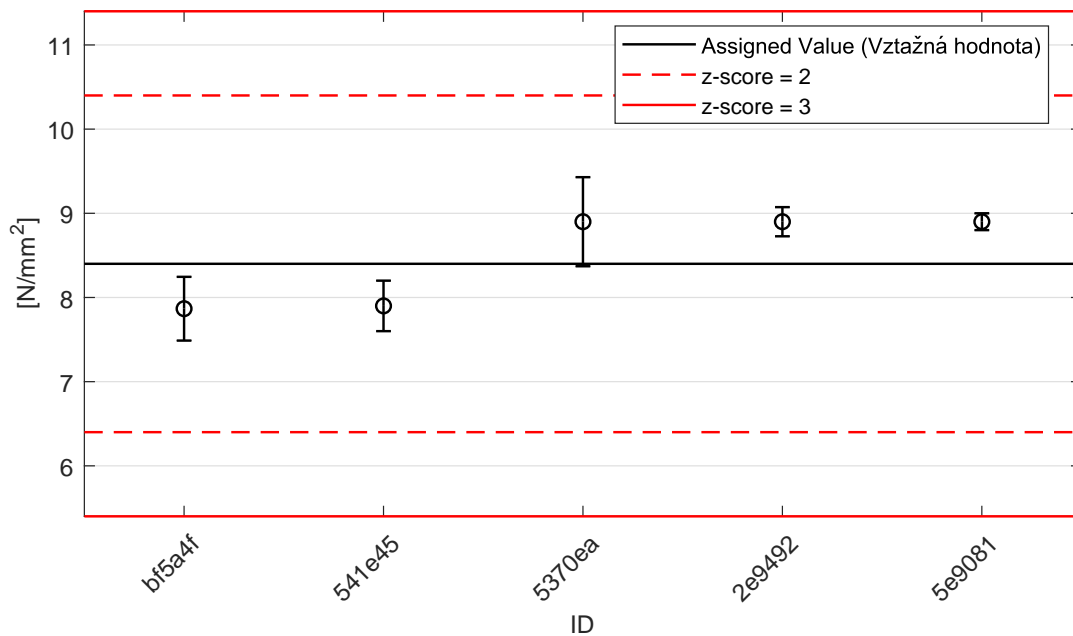### 1.3.4 Calculation of Performance Statistics

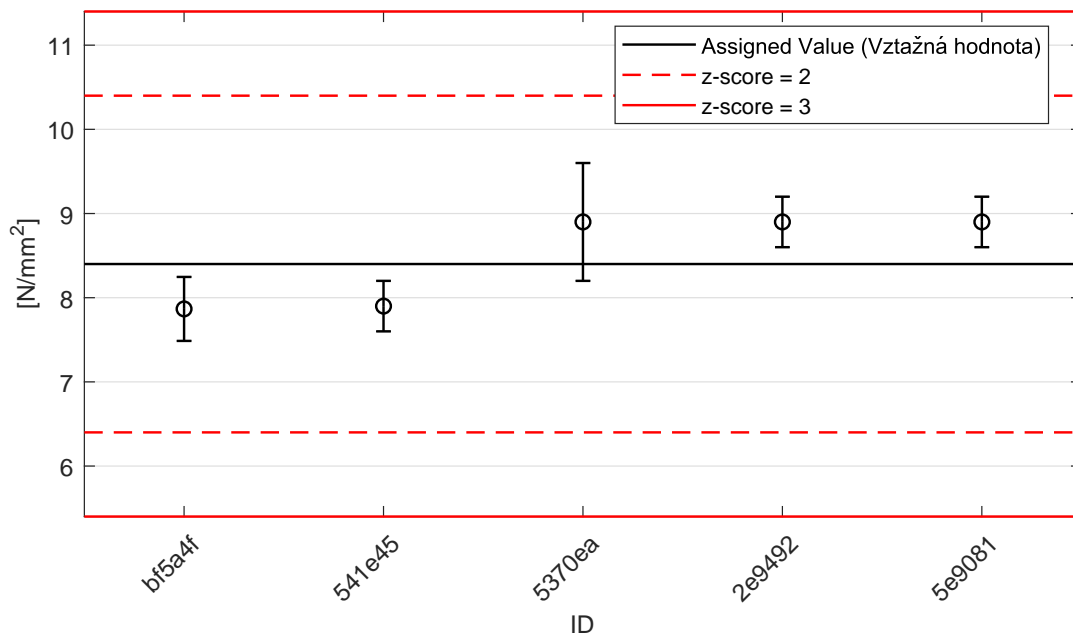Figure 21: Average values and sample standard deviations

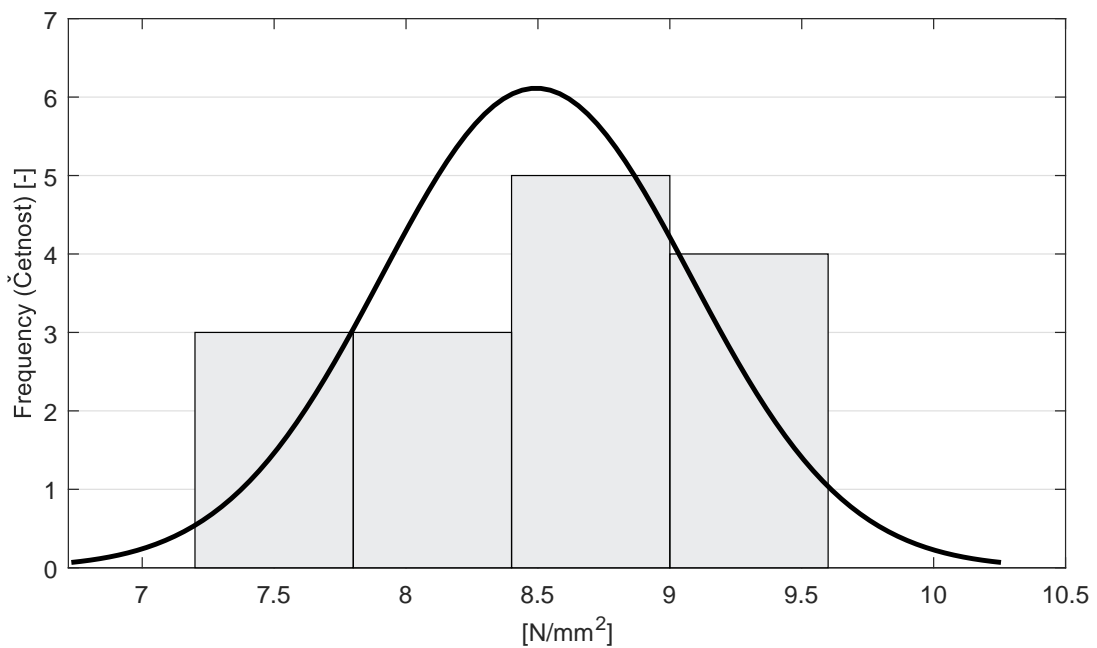Figure 22: Average values and extended uncertainties of measurement

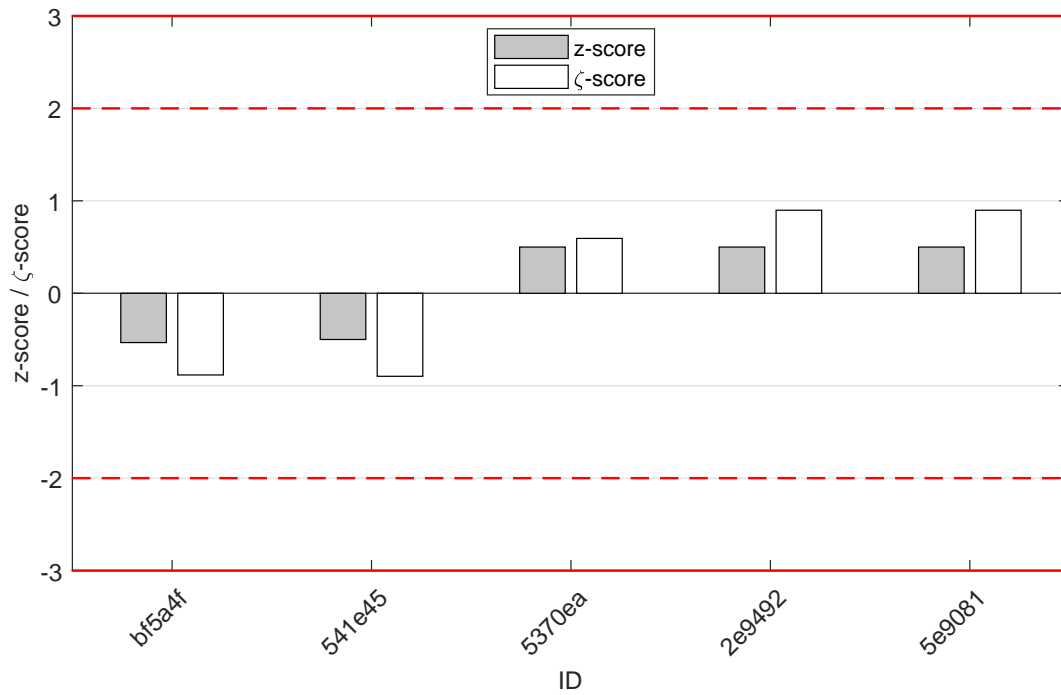Figure 23: Histogram of all test results

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

23/67

Figure 24: z-score and ζ-score

Table 8: *z*-score and *ζ*-score

ID	*z*-score [-]	*ζ*-score [-]
bf5a4f	-0.53	-0.88
541e45	-0.50	-0.90
5370ea	0.50	0.59
2e9492	0.50	0.90
5e9081	0.50	0.90

1.4 Compressive Strength after 2 days of ageing

1.4.1 Test results

Table 9: 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 [N/mm²]						u_X [N/mm²]	$\bar{x}$ [N/mm²]	s_0 [N/mm²]	V_X [%]
541e45	23.1	22.4	21.3	22.2	22.9	22.3	0.7	22.4	0.6	2.82
bf5a4f	28.5	28.1	28.0	28.3	28.2	28.6	0.2	28.3	0.2	0.82
8cbdf5	28.5	28.3	28.8	28.4	28.0	28.0	0.7	28.3	0.3	1.09
2e9492	29.9	30.3	29.7	29.3	29.5	29.9	1.0	29.8	0.4	1.18
5e9081	29.1	30.7	29.9	30.5	30.2	30.1	-	30.1	0.6	1.86

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

24/67

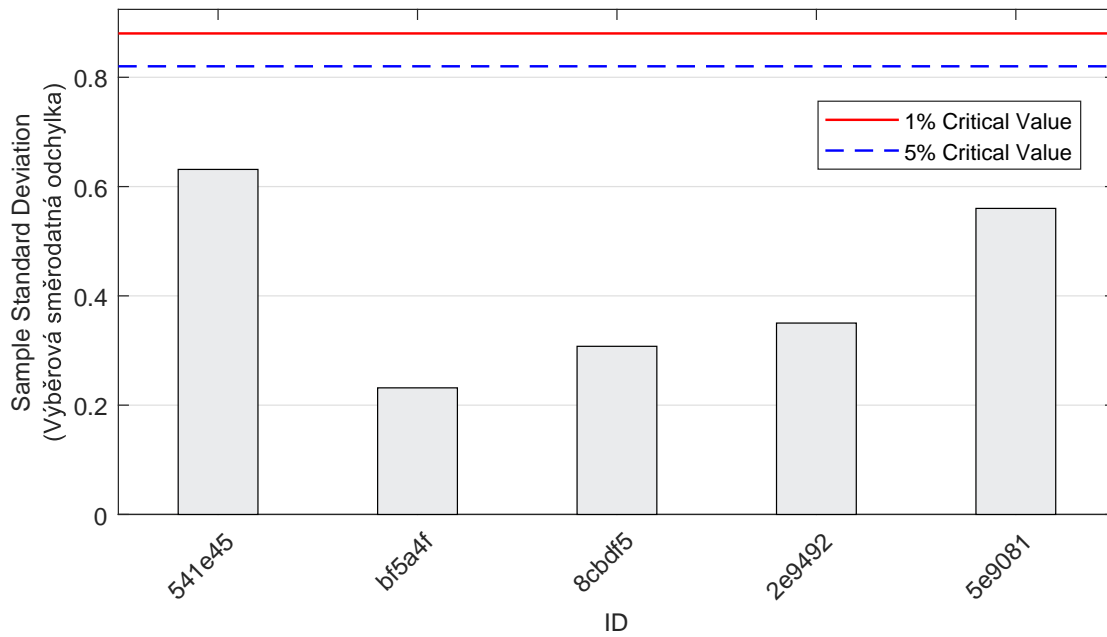### 1.4.2 The Numerical Procedure for Determining Outliers

Figure 25: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
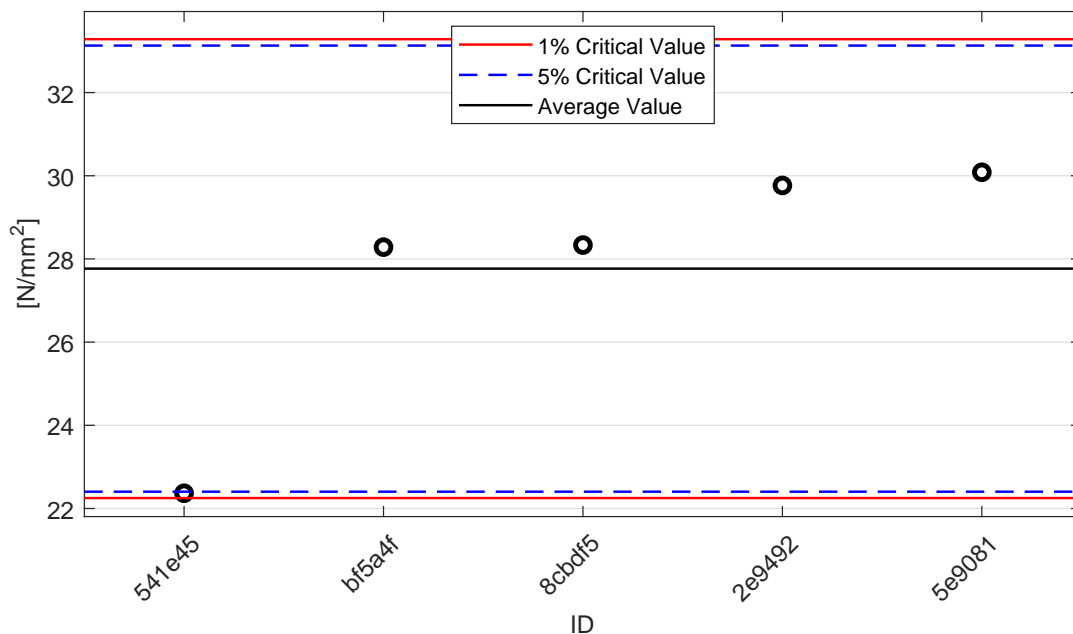

Figure 26: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   25/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
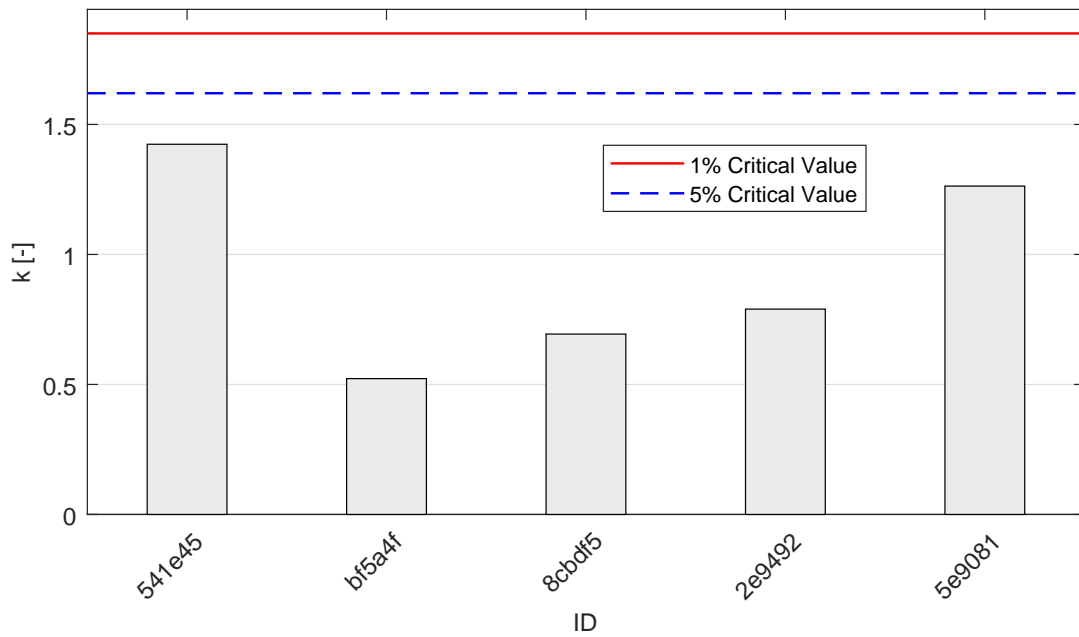szk.fce.vutbr.cz | ptprovider.cz

1.4.3 Mandel's Statistics

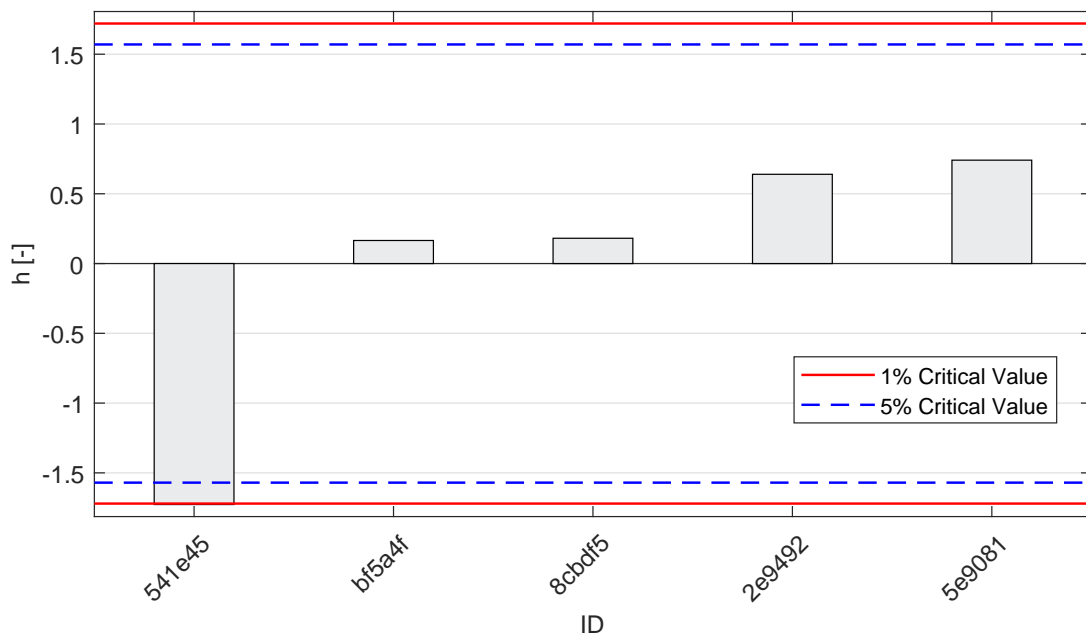Figure 27: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Figure 28: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   26/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

1.4.4 Calculation of Performance Statistics
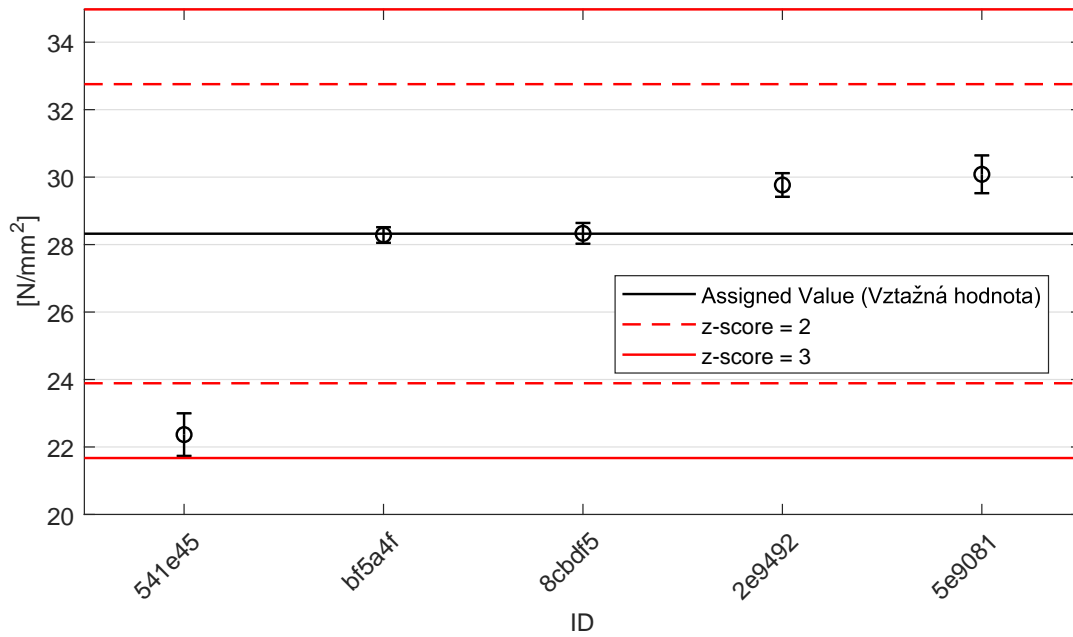

Figure 29: Average values and sample standard deviations

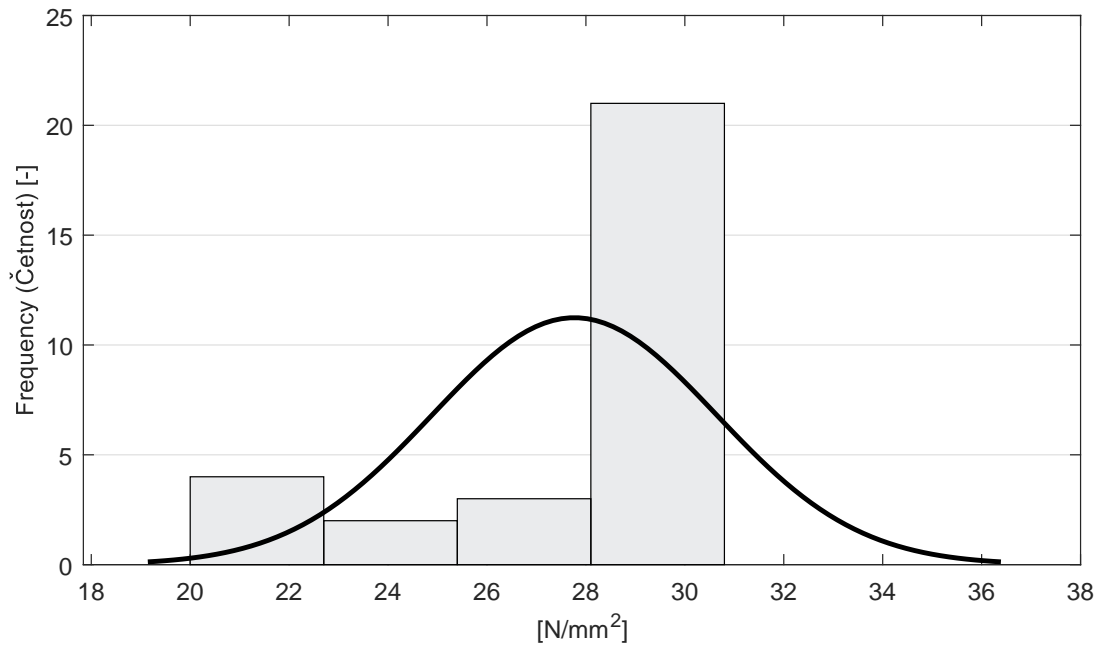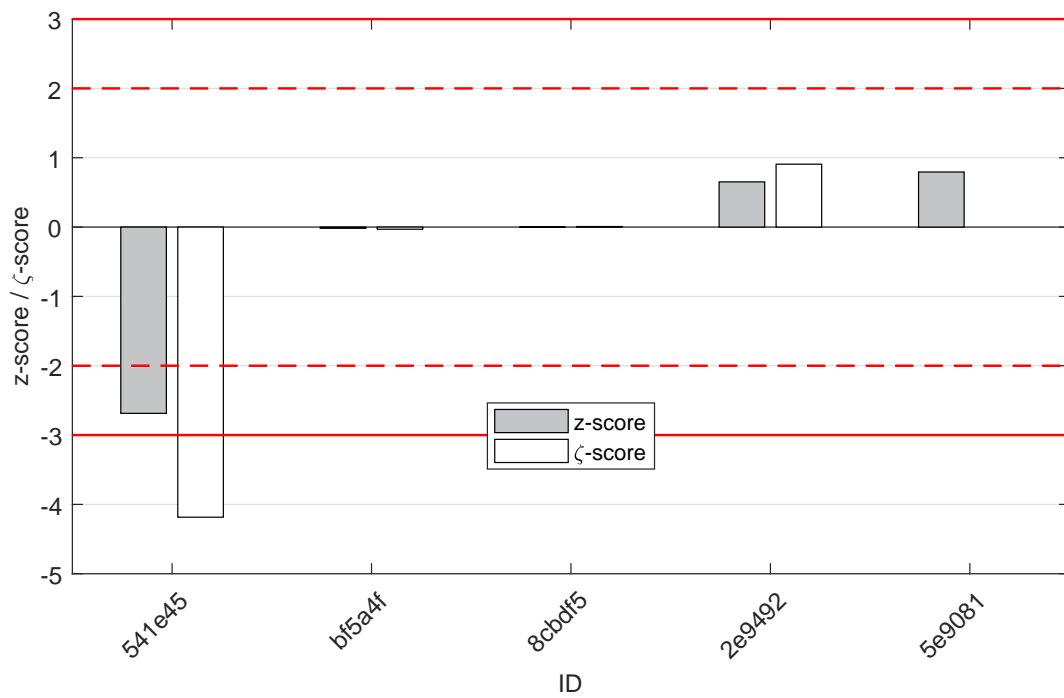Figure 30: Average values and extended uncertainties of measurement

Proficiency Testing Provider at the SZK FAST | Z 7008   27/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Figure 31: Histogram of all test results

Figure 32: z-score and ζ-score

Proficiency Testing Provider at the SZK FAST | Z 7008   28/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Table 10: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
541e45	-2.69	-4.18
bf5a4f	-0.02	-0.03
8cbdf5	0.00	0.01
2e9492	0.65	0.91
5e9081	0.79	-

1.5 Compressive Strength after 7 days of ageing

1.5.1 Test results

Table 11: 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

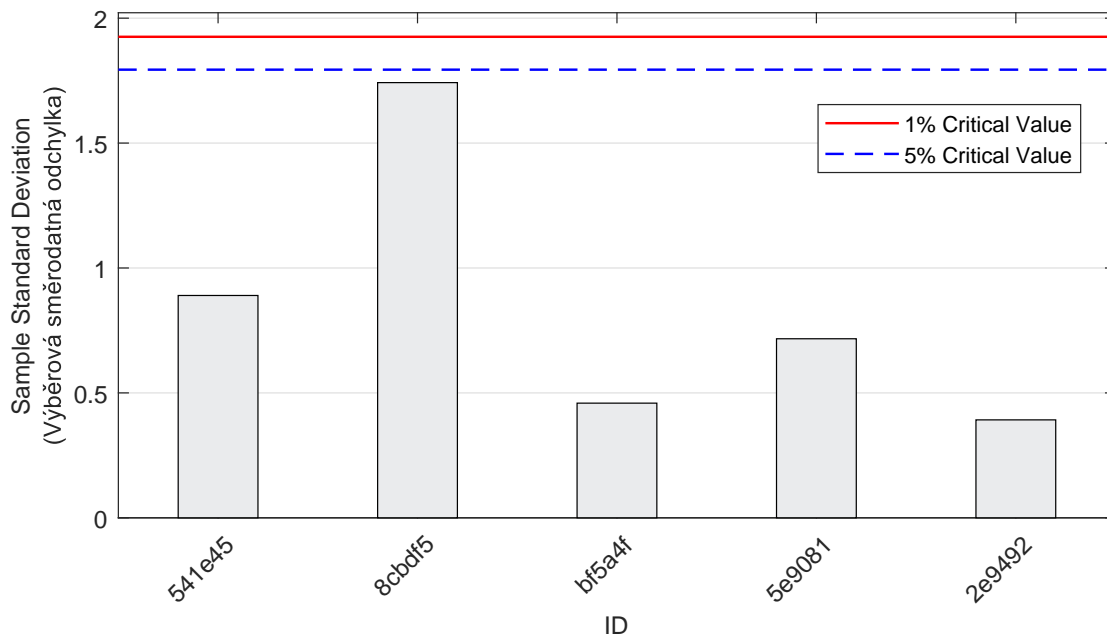| ID of participant	Test results [N/mm^2]						u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
541e45	40.5	41.9	41.6	39.6	41.1	40.1	1.3	40.8	0.9	2.18
8cbdf5	40.4	44.2	44.9	42.8	43.5	41.2	1.3	42.8	1.7	4.07
bf5a4f	49.2	50.4	49.3	49.7	49.7	50.1	0.5	49.7	0.5	0.92
5e9081	50.7	51.9	50.5	50.1	49.9	51.0	-	50.7	0.7	1.41
2e9492	53.1	52.9	53.3	52.9	52.4	52.3	1.8	52.8	0.4	0.74

1.5.2 The Numerical Procedure for Determining Outliers

Figure 33: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
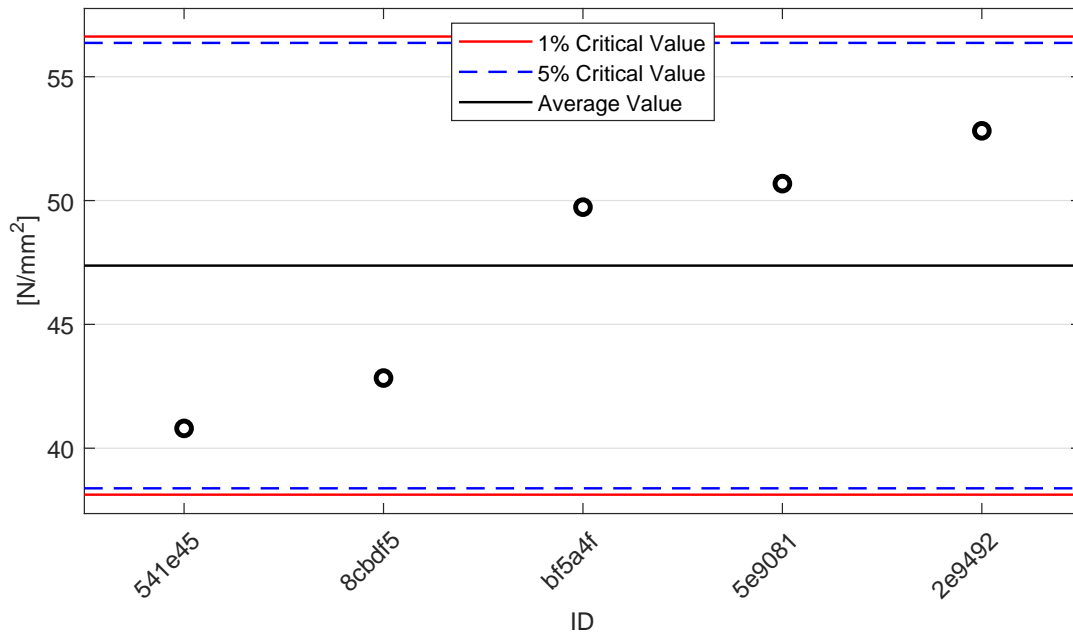szk.fce.vutbr.cz | ptprovider.cz

29/67

Figure 34: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color
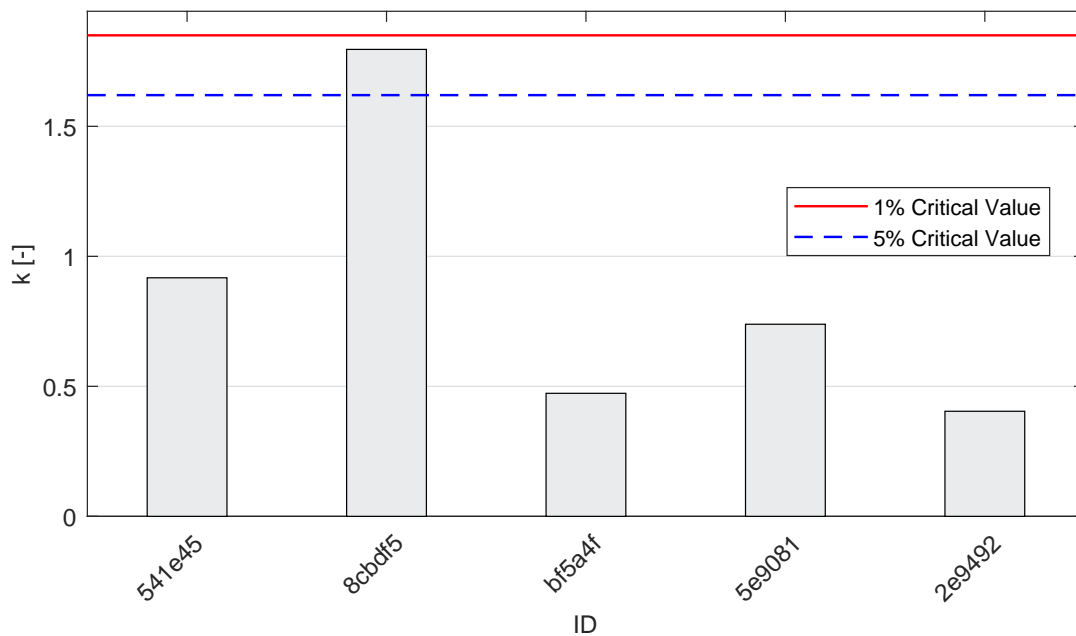
1.5.3 Mandel's Statistics

Figure 35: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color
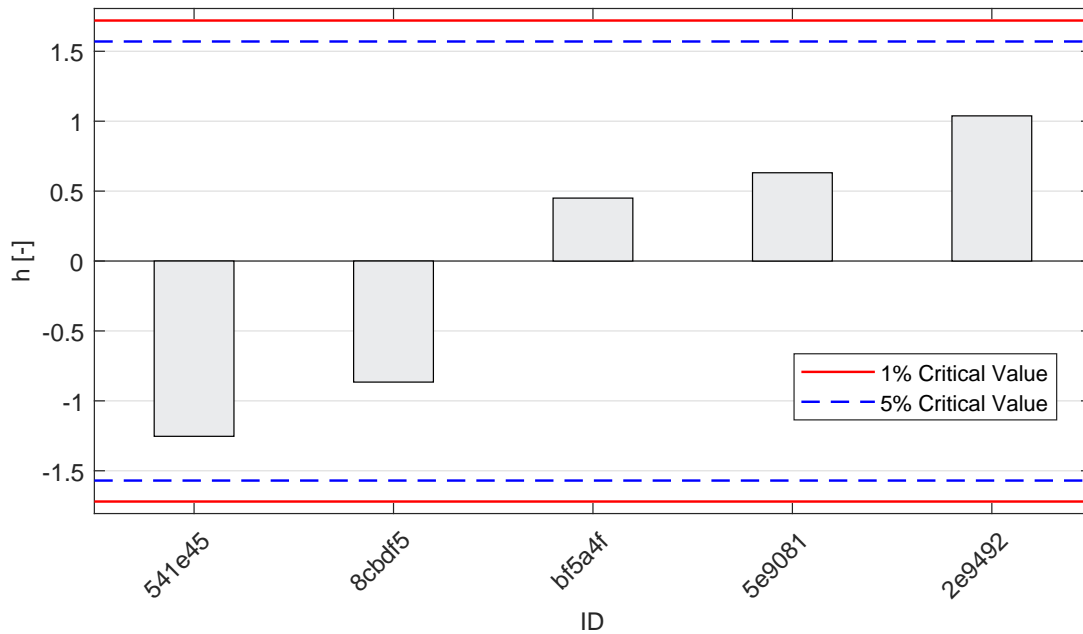
Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

30/67

Figure 36: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color

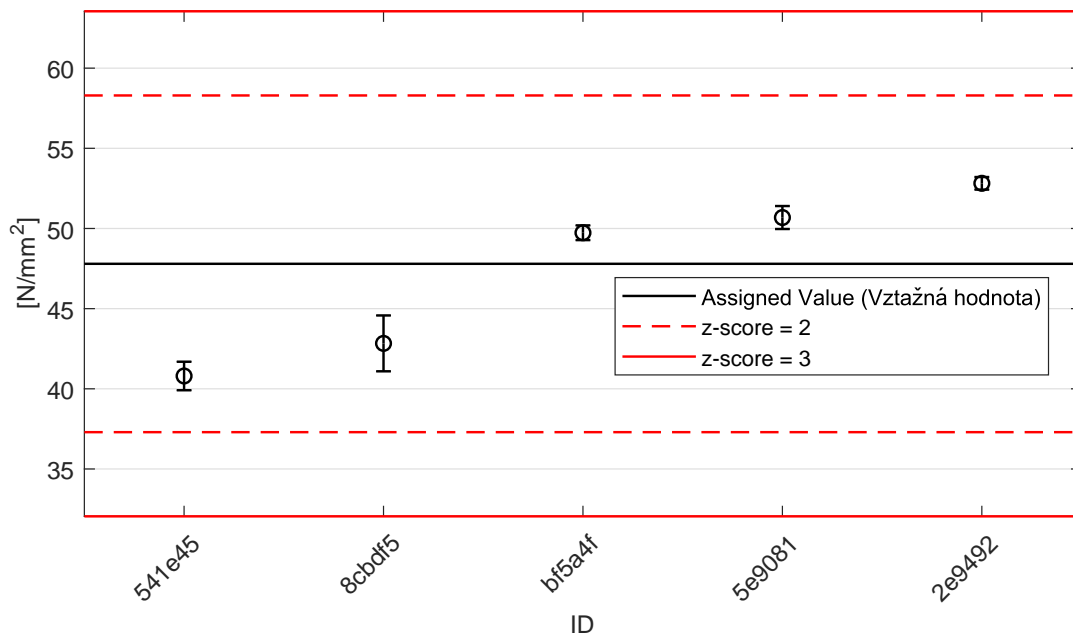### 1.5.4 Calculation of Performance Statistics

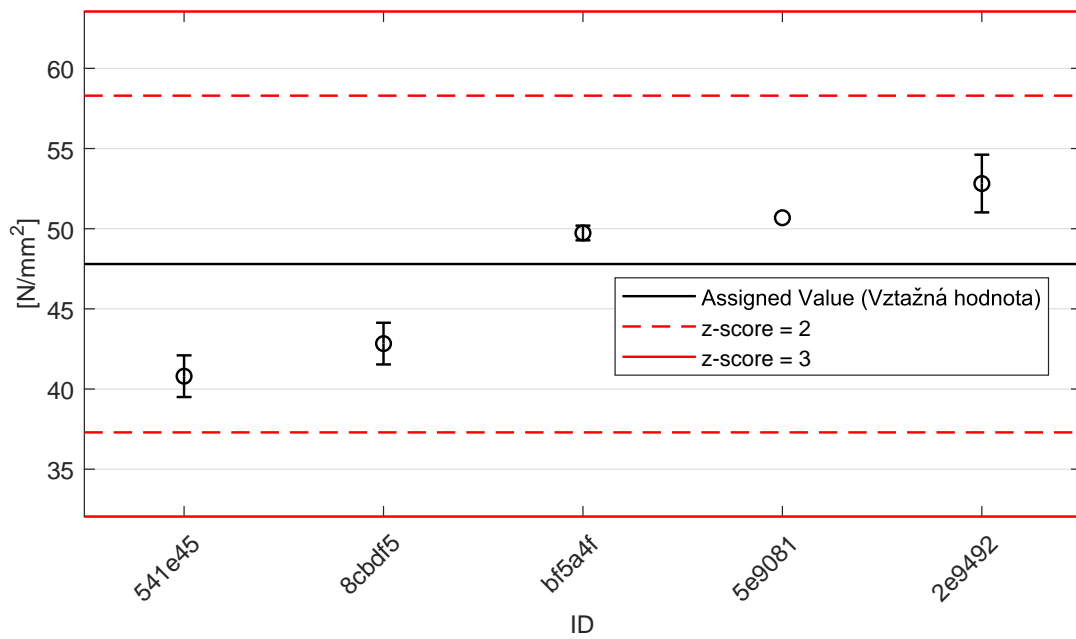Figure 37: Average values and sample standard deviations

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

31/67

Figure 38: Average values and extended uncertainties of measurement

Figure 39: Histogram of all test results

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

32/67

Figure 40: z-score and ζ-score

Table 12: *z*-score and *ζ*-score

ID	z-score [-]	ζ-score [-]
541e45	-1.33	-2.18
8cbdf5	-0.95	-1.55
bf5a4f	0.37	0.65
5e9081	0.55	-
2e9492	0.96	1.46

1.6 Compressive Strength after 28 days of ageing

1.6.1 Test results

Table 13: 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 [N/mm^2]						u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
576ad3	50.2	49.0	47.1	48.9	48.4	48.0	1.1	48.6	1.0	2.15
541e45	54.5	51.1	53.9	53.1	54.7	55.1	1.8	53.7	1.5	2.73
8cbdf5	52.9	51.8	56.1	55.2	53.2	53.6	1.8	53.8	1.6	2.93
5370ea	59.1	60.4	56.8	58.1	59.5	55.4	1.5	58.2	1.9	3.18
5e9081	58.5	58.8	59.0	58.8	58.2	57.9	1.2	58.5	0.4	0.71
2e9492	56.8	63.3	63.7	62.0	60.7	64.4	2.1	61.8	2.8	4.51
bf5a4f	64.5	61.5	62.7	61.3	62.4	61.7	1.2	62.3	1.2	1.90

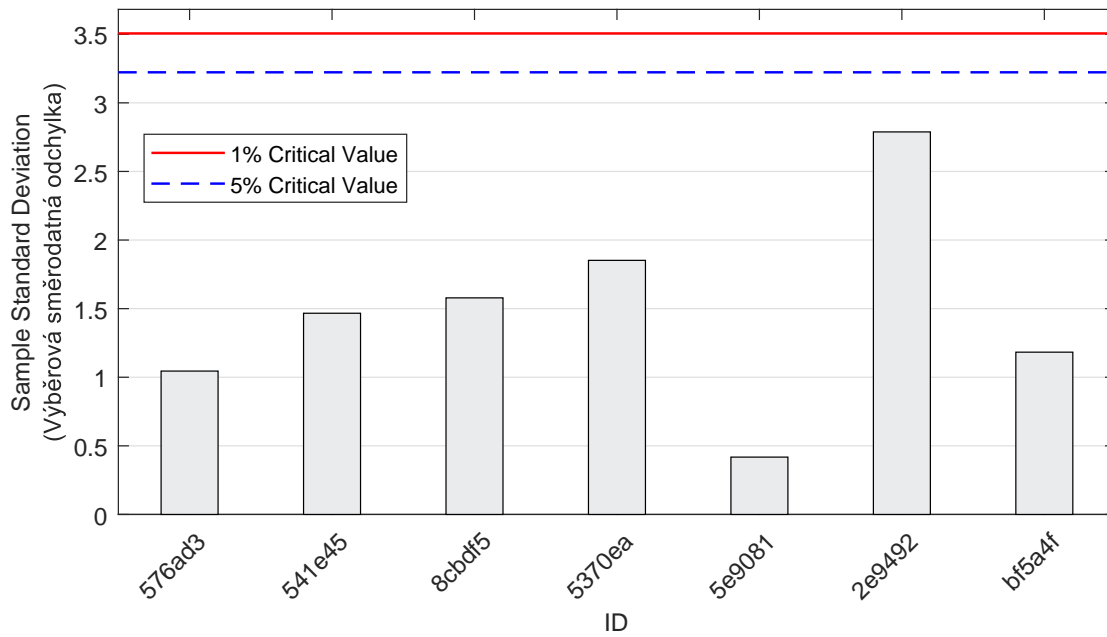### 1.6.2 The Numerical Procedure for Determining Outliers

Figure 41: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
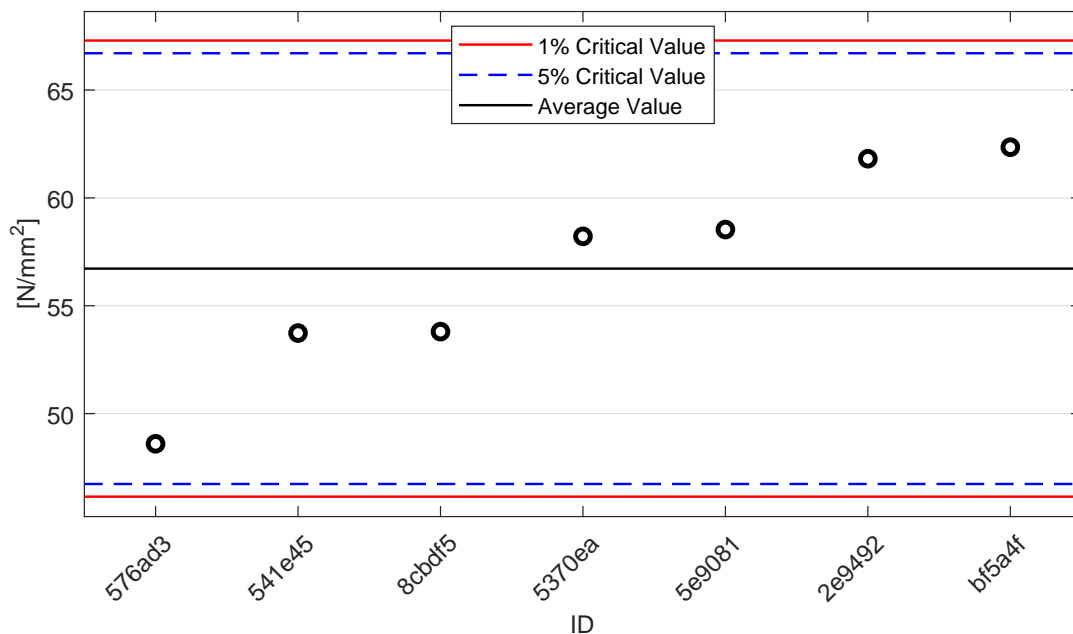

Figure 42: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008
34/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

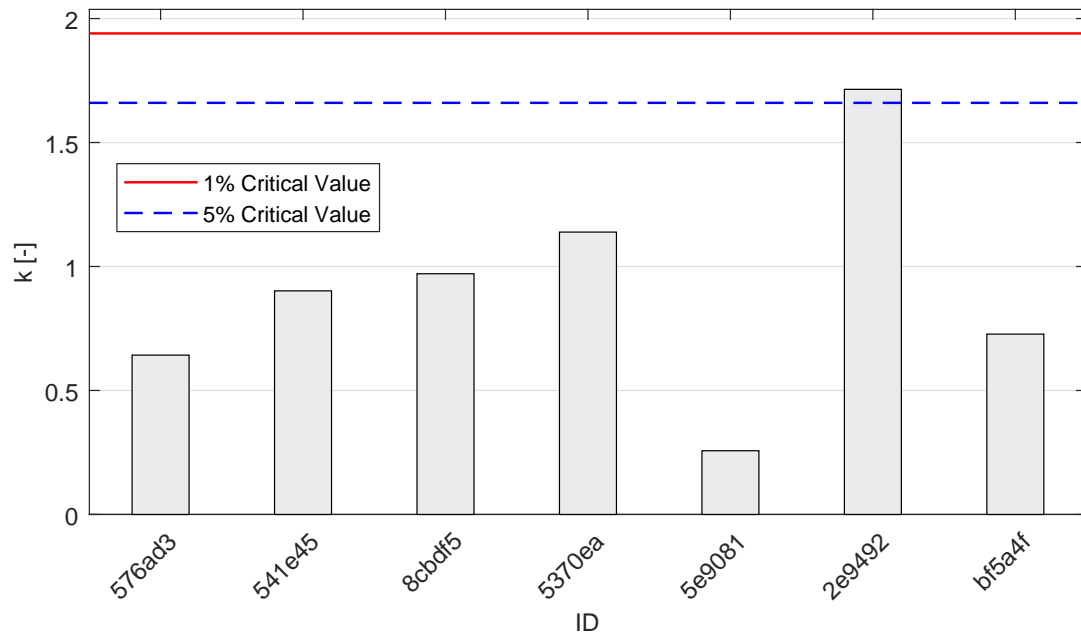### 1.6.3 Mandel's Statistics

Figure 43: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color
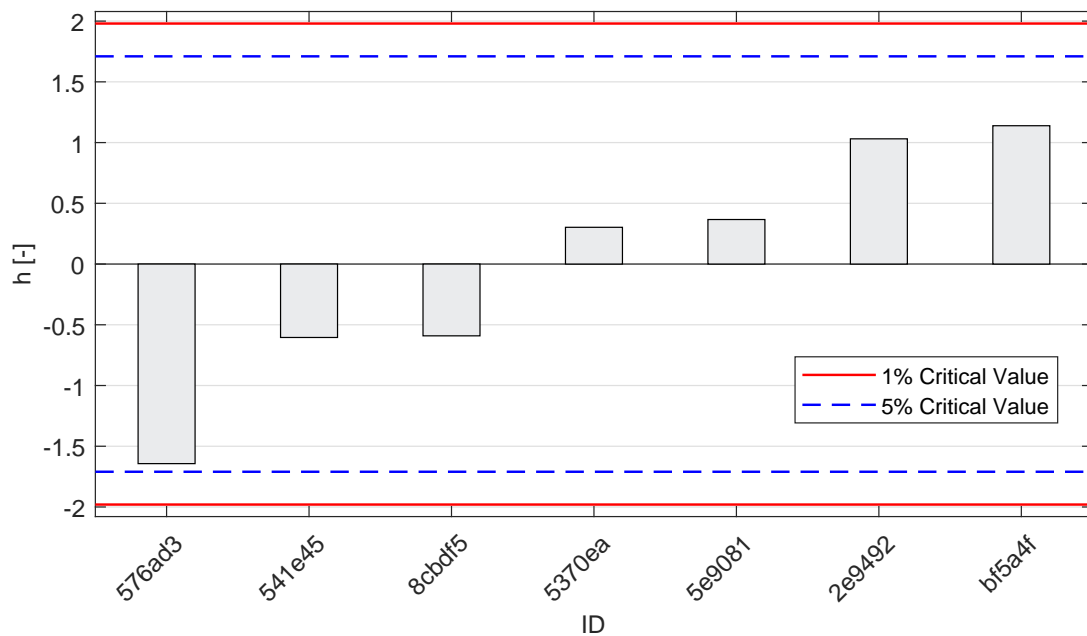

Figure 44: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

35/67

1.6.4 Calculation of Performance Statistics
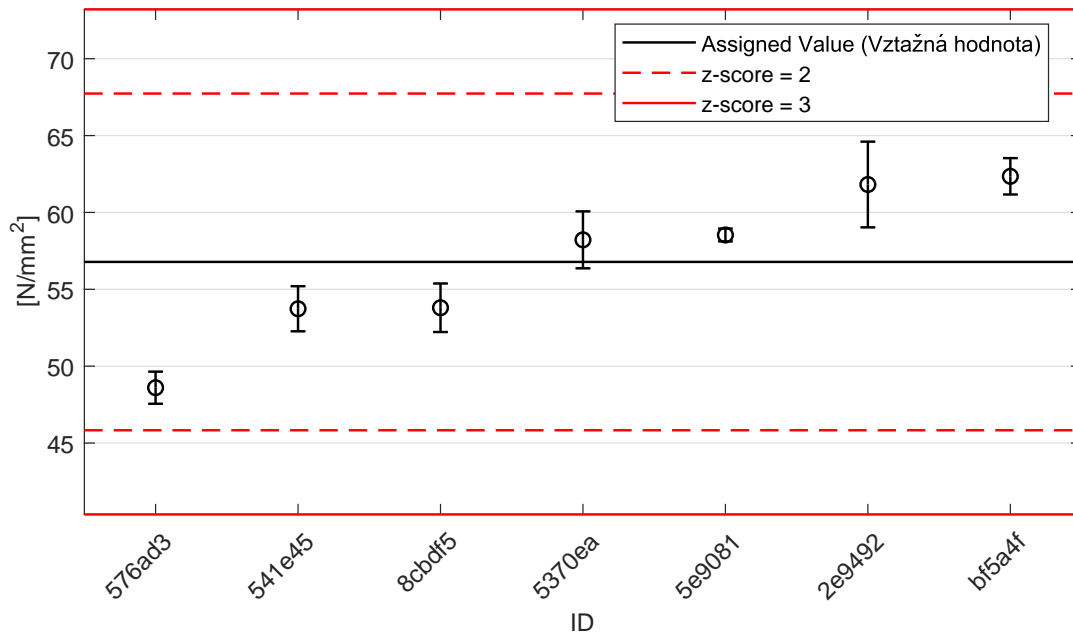

Figure 45: Average values and sample standard deviations

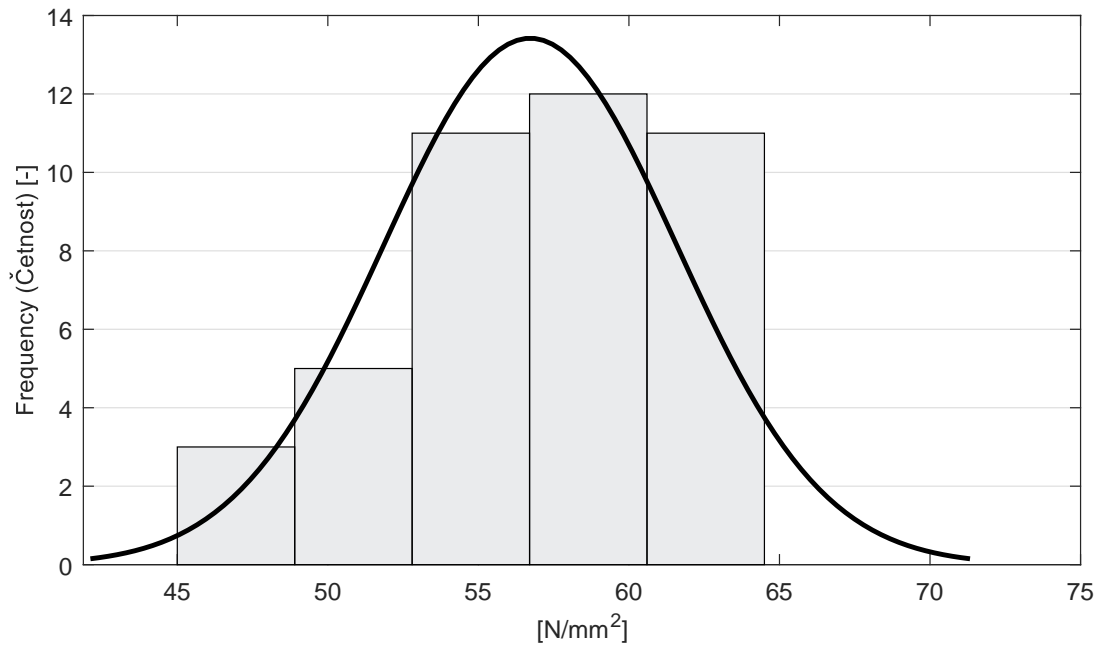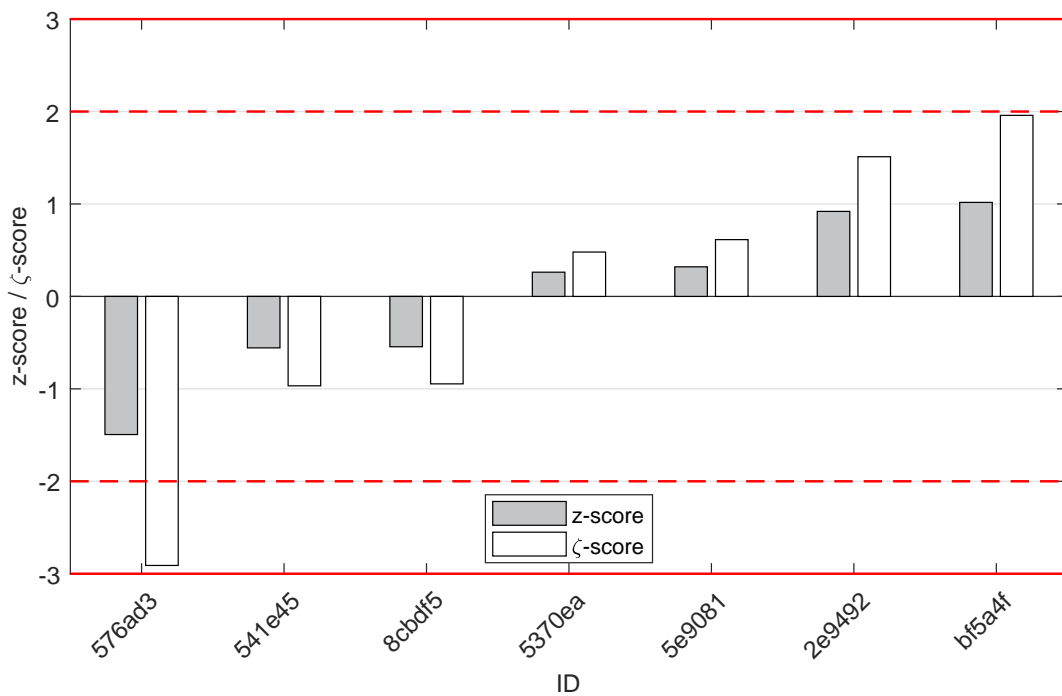Figure 46: Average values and extended uncertainties of measurement

Proficiency Testing Provider at the SZK FAST | Z 7008
36/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Figure 47: Histogram of all test results

Figure 48: z-score and ζ-score

Proficiency Testing Provider at the SZK FAST | Z 7008
37/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Table 14: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
576ad3	-1.49	-2.91
541e45	-0.56	-0.97
8cbdf5	-0.54	-0.95
5370ea	0.26	0.48
5e9081	0.32	0.61
2e9492	0.92	1.51
bf5a4f	1.02	1.96

1.7 Summary

1.7.1 Flexural Strength
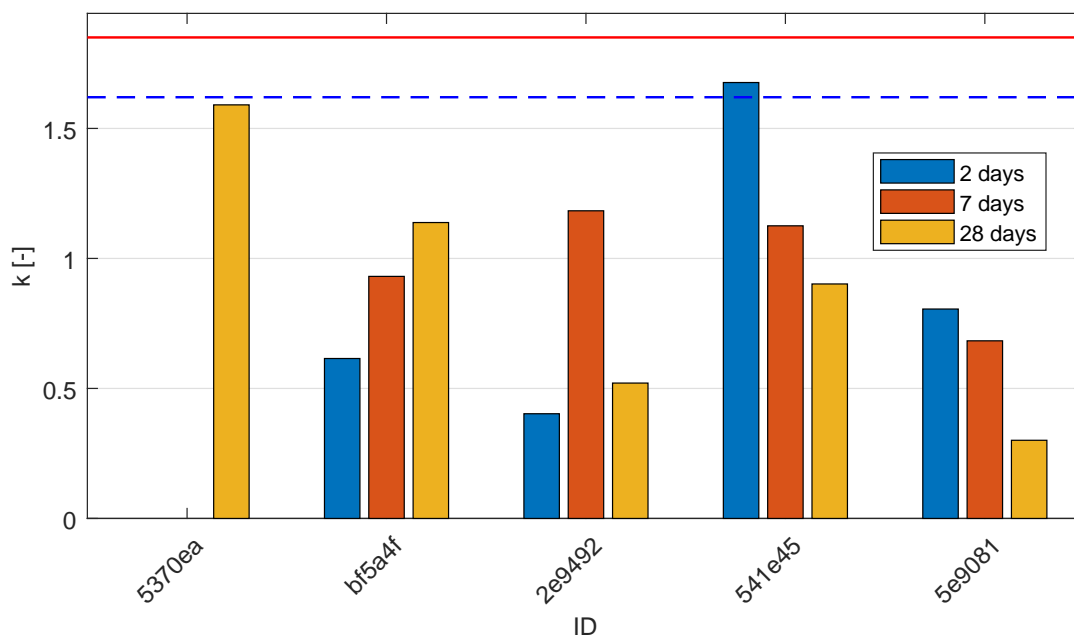

Figure 49: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008
38/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
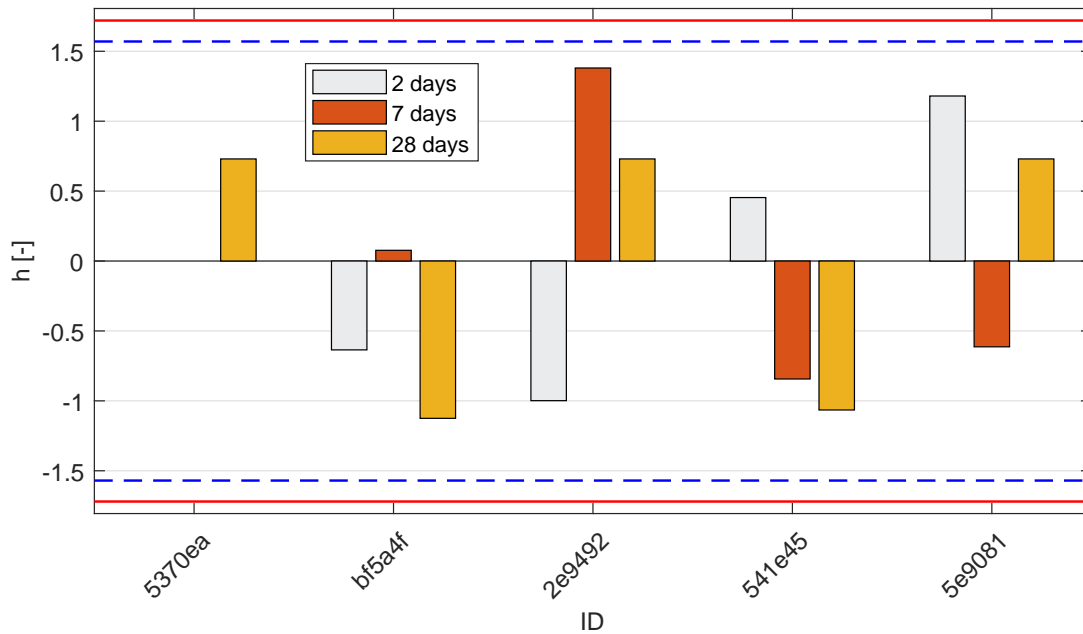szk.fce.vutbr.cz | ptprovider.cz

Figure 50: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color
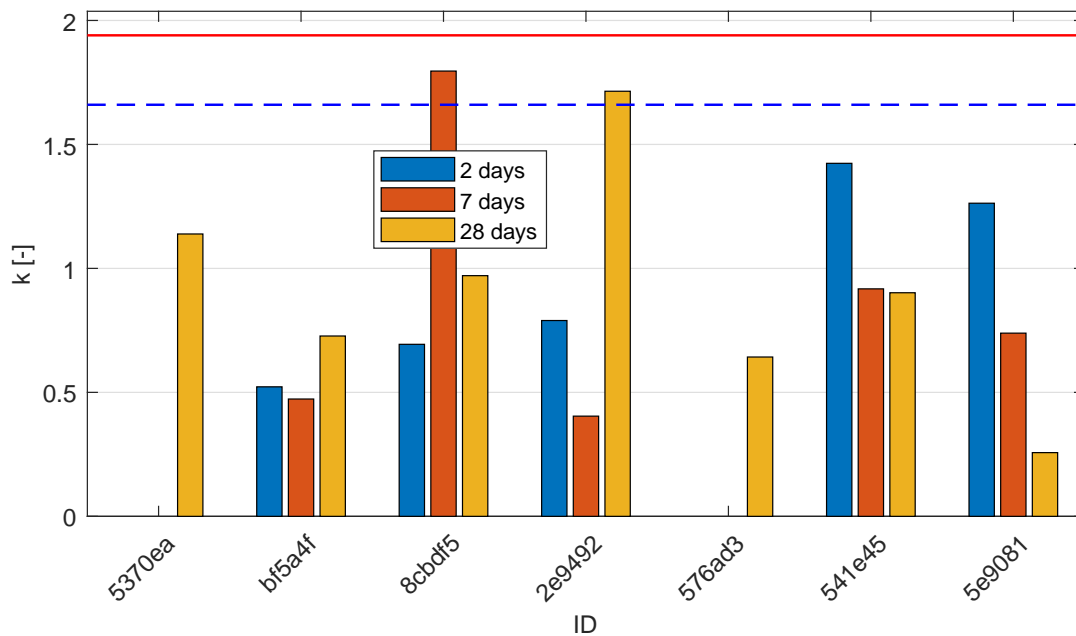
1.7.2 Compressive Strength

Figure 51: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   39/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
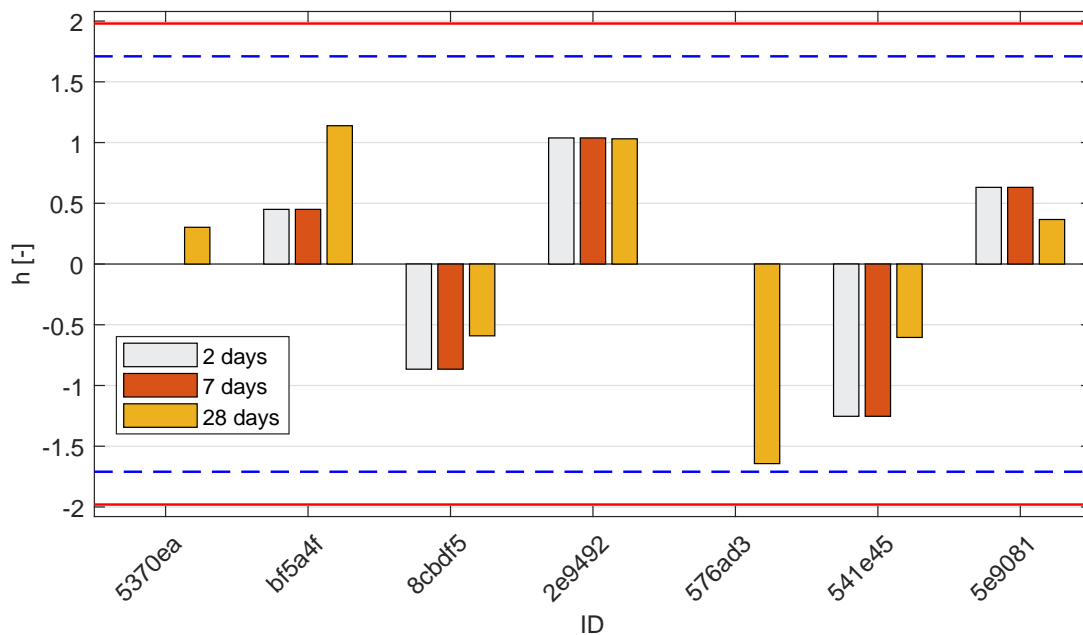szk.fce.vutbr.cz | ptprovider.cz

Figure 52: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

2 Appendix – EN 196-2 (Chapter 7) – Determination of loss on ignition

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

3 Appendix – EN 196-2 (Chapter 8) – Determination of sulphate content

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

4 Appendix – EN 196-2 (Chapter 9) – Remainder determination

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

5 Appendix – EN 196-2 (Chapter 10) – Remainder determination

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

6 Appendix – EN 196-2 (Chapter 11) – Determination of sulphite content

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

7 Appendix – EN 196-3 – Setting time, Volume weight

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

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

40/67

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

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

9 Appendix – EN 1015-1 – Granularity

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

10 Appendix – EN 1015-3 – Consistency

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

11 Appendix – EN 1015-6 – Volume Weight

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

12 Appendix – EN 1015-10 – Volume Weight

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

13 Appendix – EN 1015-11 – Strength

13.1 Flexural Strength

13.1.1 Test results

Table 15: 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 [N/mm^2]			u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
eb4d30	1.4	1.9	1.7	0.1	1.7	0.2	13.89
f56ca2	1.8	1.6	1.6	0.1	1.7	0.1	6.95
f099ab	1.8	1.9	2.0	0.3	1.9	0.1	6.51
81b7ec	2.1	2.0	2.2	0.1	2.1	0.1	3.58
c9cb0d	2.2	2.5	2.3	0.0	2.3	0.1	6.13
502fd5	2.6	2.4	2.5	0.0	2.5	0.1	4.14
eab579*	32.3*	34.5*	36.9*	3.5*	34.5*	2.3*	6.61*

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

41/67

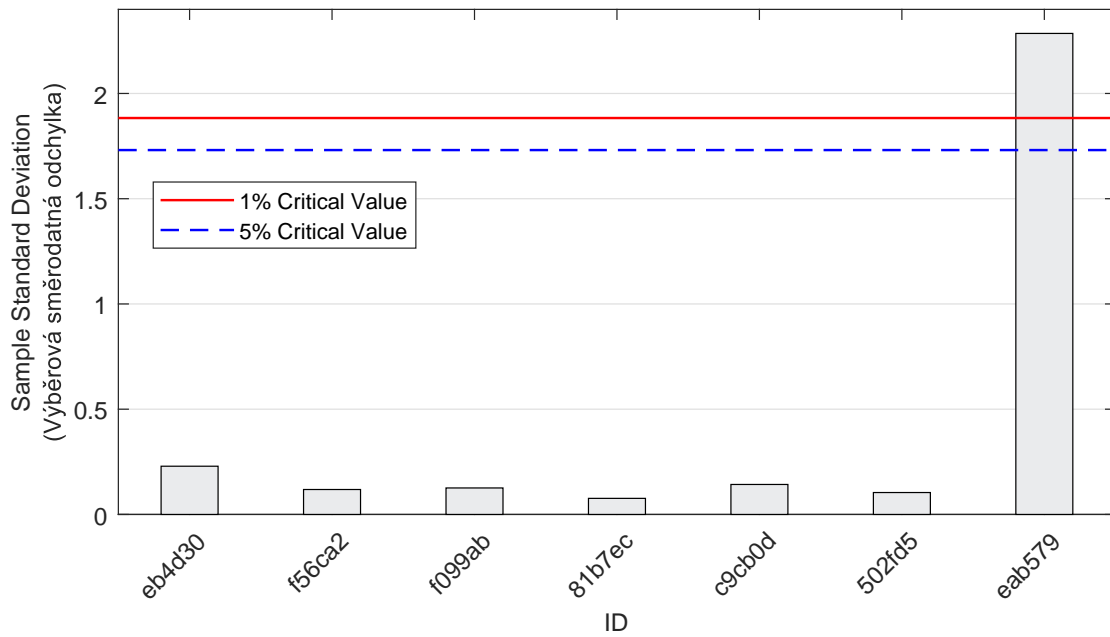## 13.1.2 The Numerical Procedure for Determining Outliers

Figure 53: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
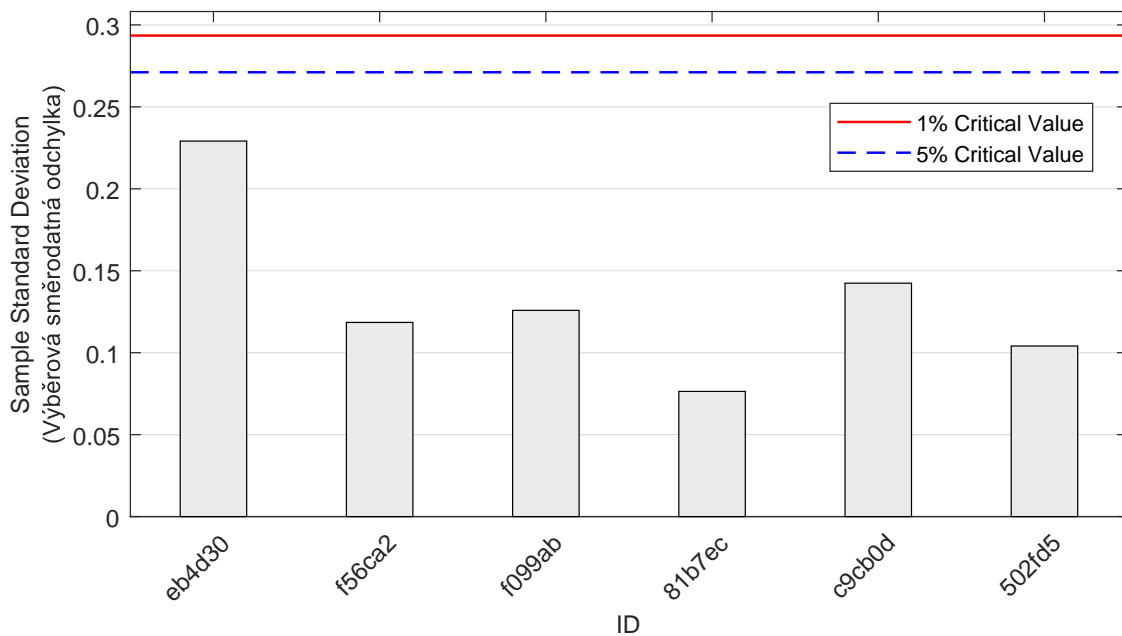

Figure 54: **Cochran's test** - sample standard deviations without outliers: 1% critical value - red color; 5% critical value - blue color
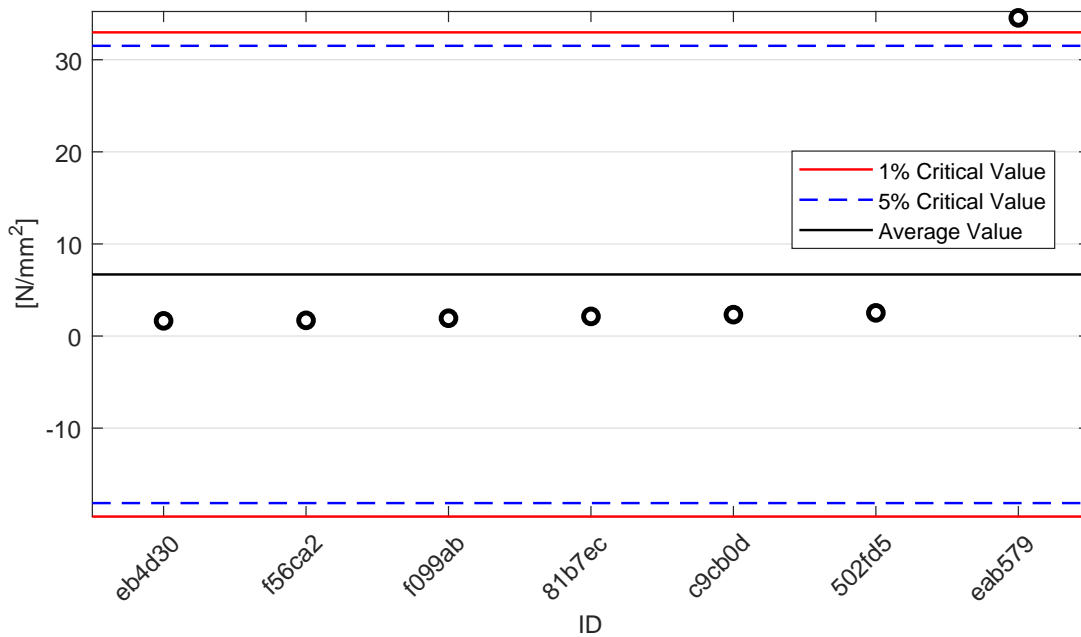
Proficiency Testing Provider at the SZK FAST | Z 7008   42/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Figure 55: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color
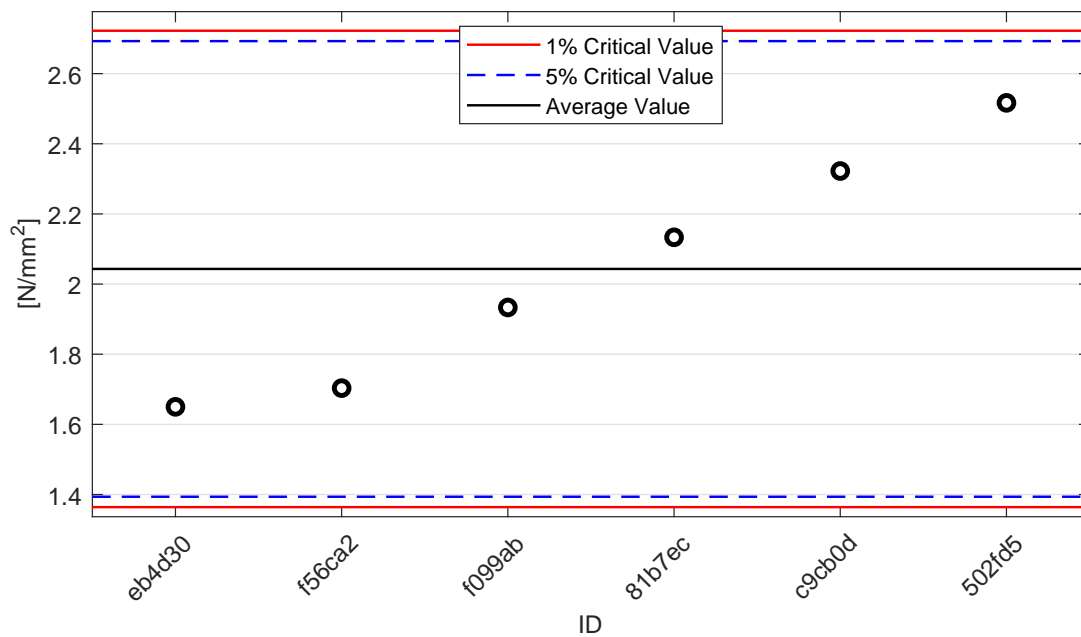

Figure 56: **Grubbs' test** - average values without outliers: 1% critical value - red color; 5% critical value - blue color
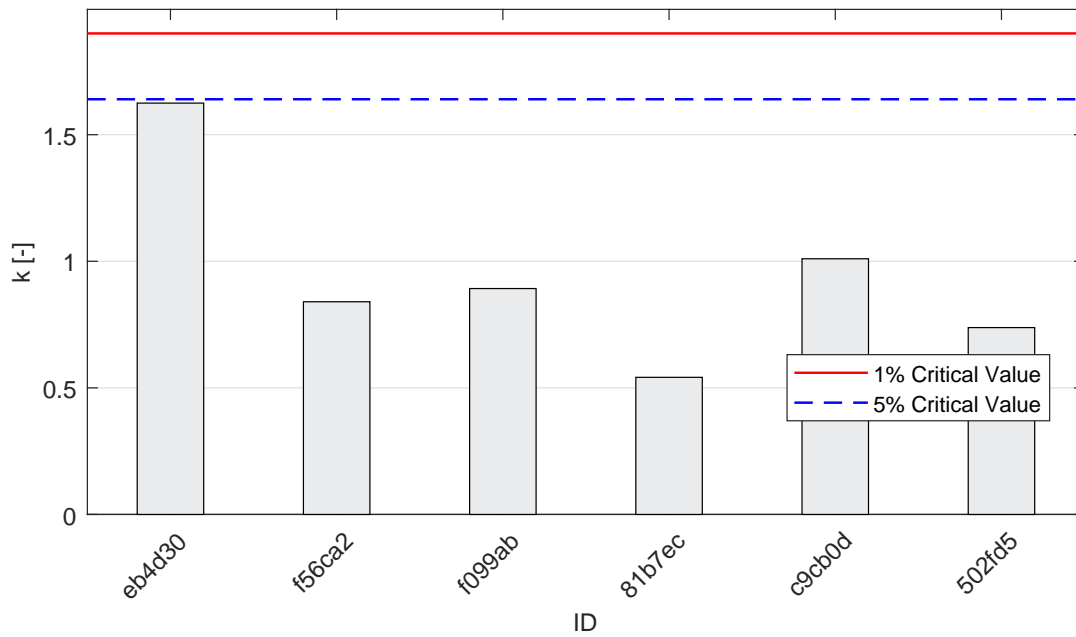
Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

43/67

13.1.3 Mandel's Statistics

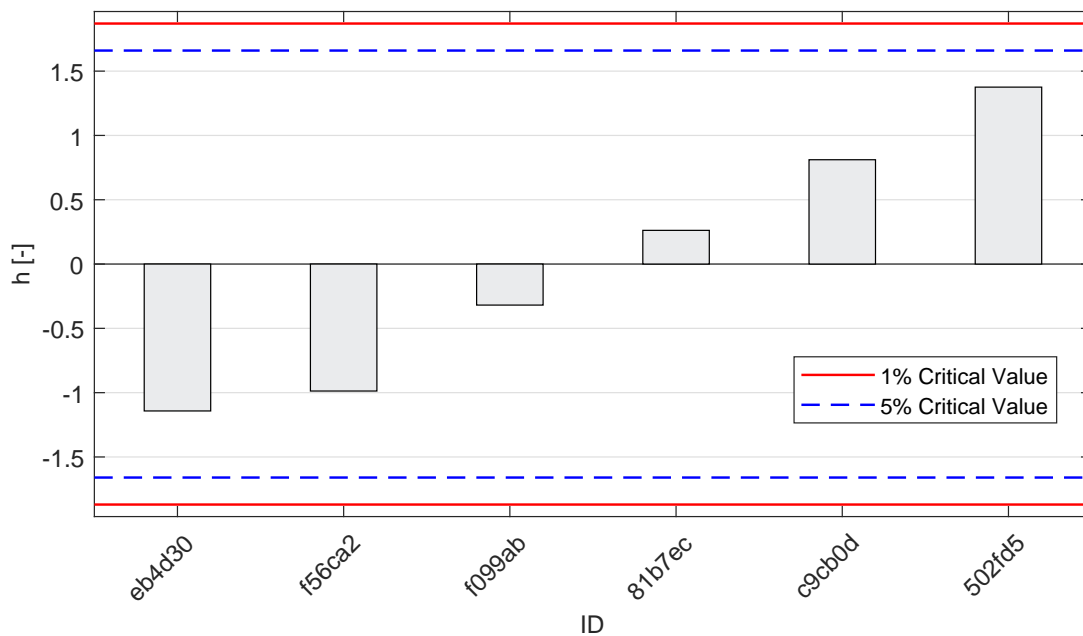Figure 57: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Figure 58: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color
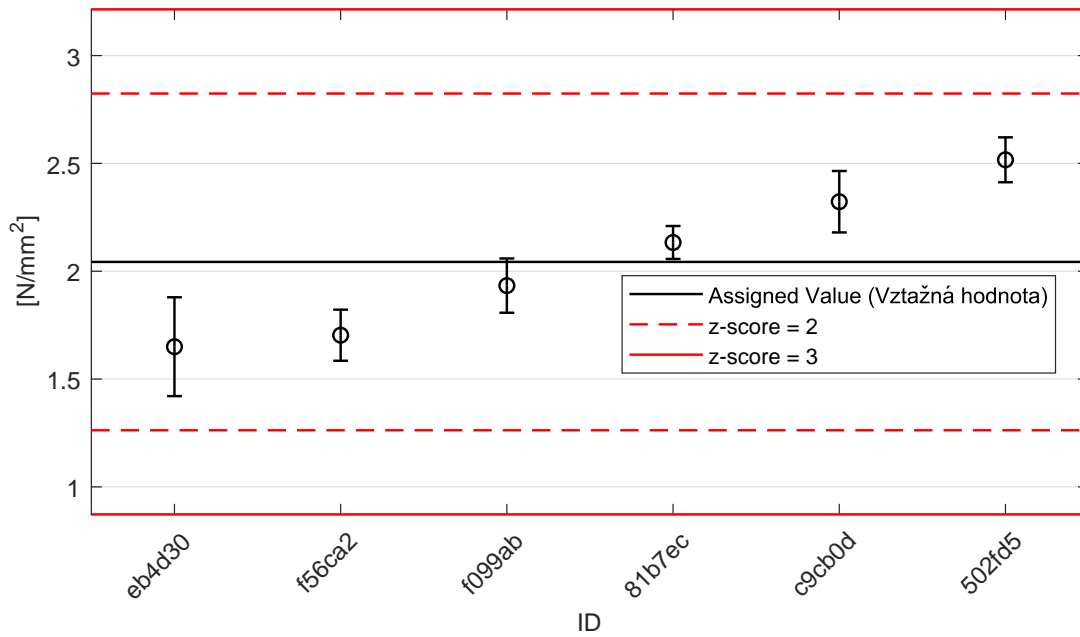
13.1.4 Calculation of Performance Statistics

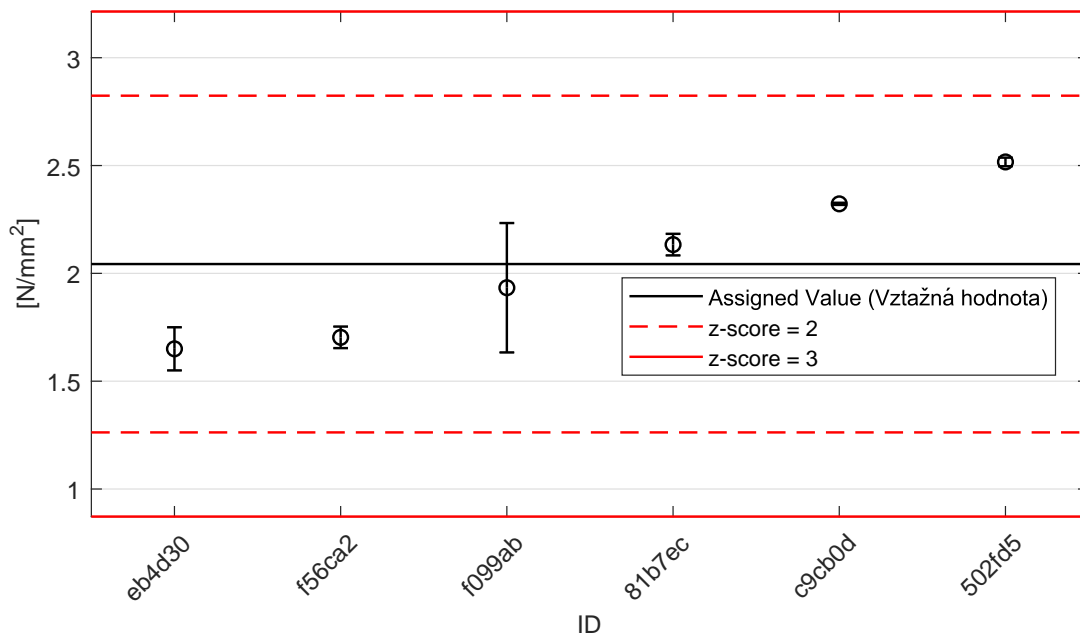
Figure 59: Average values and sample standard deviations

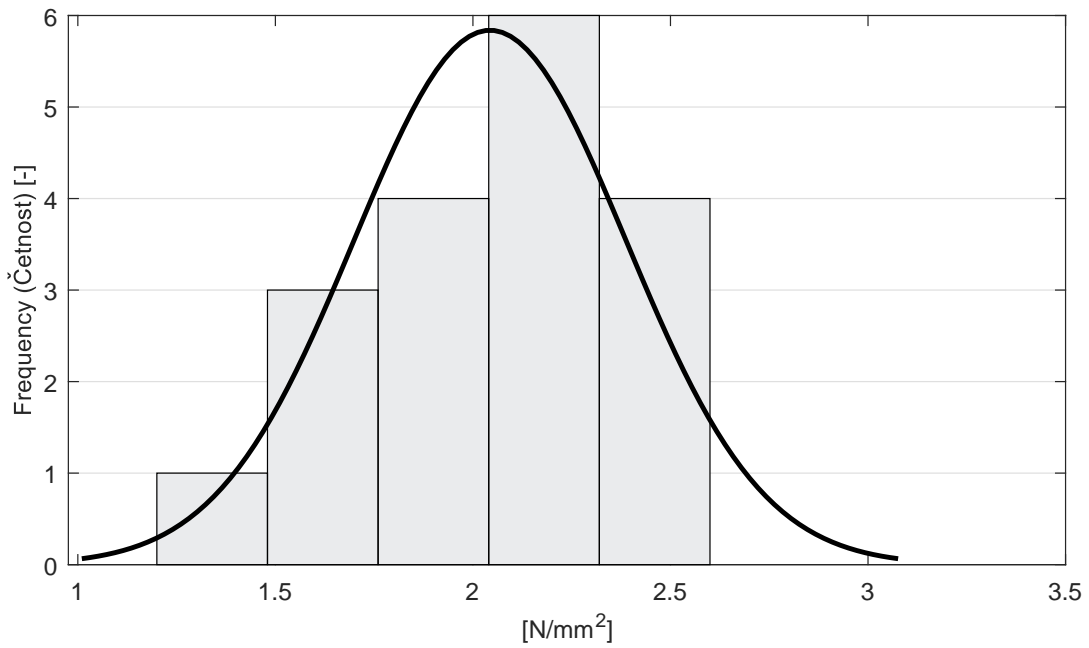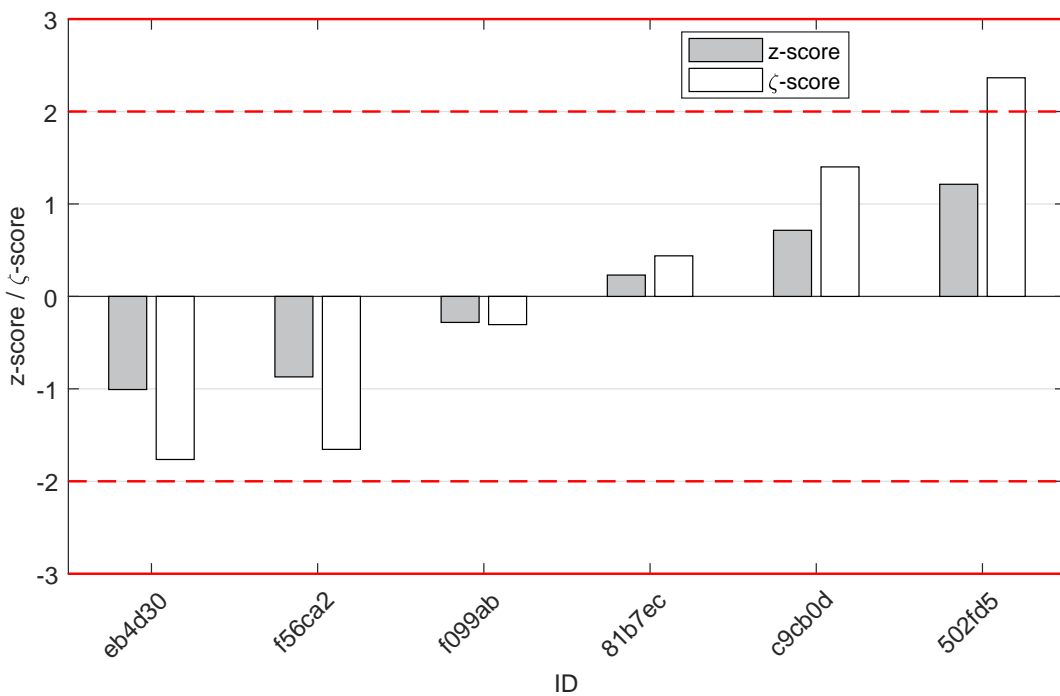Figure 60: Average values and extended uncertainties of measurement

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

45/67

Figure 61: Histogram of all test results

Figure 62: z-score and ζ-score

Table 16: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
eb4d30	-1.01	-1.76
f56ca2	-0.87	-1.65
f099ab	-0.28	-0.31
81b7ec	0.23	0.44
c9cb0d	0.72	1.40
502fd5	1.21	2.37

13.2 Compressive Strength

13.2.1 Test results

Table 17: 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 [N/mm^2]						u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
576ad3	6.1	5.9	5.6	5.2	5.4	5.1	0.4	5.6	0.4	7.09
f56ca2	5.6	5.8	5.4	5.9	5.7	5.9	0.2	5.7	0.2	3.40
eb4d30	6.0	6.0	6.2	5.8	6.1	6.1	0.4	6.0	0.1	2.33
f099ab	6.3	6.5	6.4	6.2	6.3	6.3	0.4	6.3	0.1	2.01
81b7ec	7.3	7.5	7.0	7.1	7.3	7.5	0.1	7.3	0.2	2.51
502fd5	9.0	9.1	8.5	8.5	8.9	8.6	0.0	8.8	0.3	3.03
c9cb0d	10.7	10.9	10.6	10.2	10.1	10.4	0.0	10.5	0.3	2.88
eab579	10.9	10.7	10.7	10.8	10.8	10.9	0.1	10.8	0.1	0.83

13.2.2 The Numerical Procedure for Determining Outliers
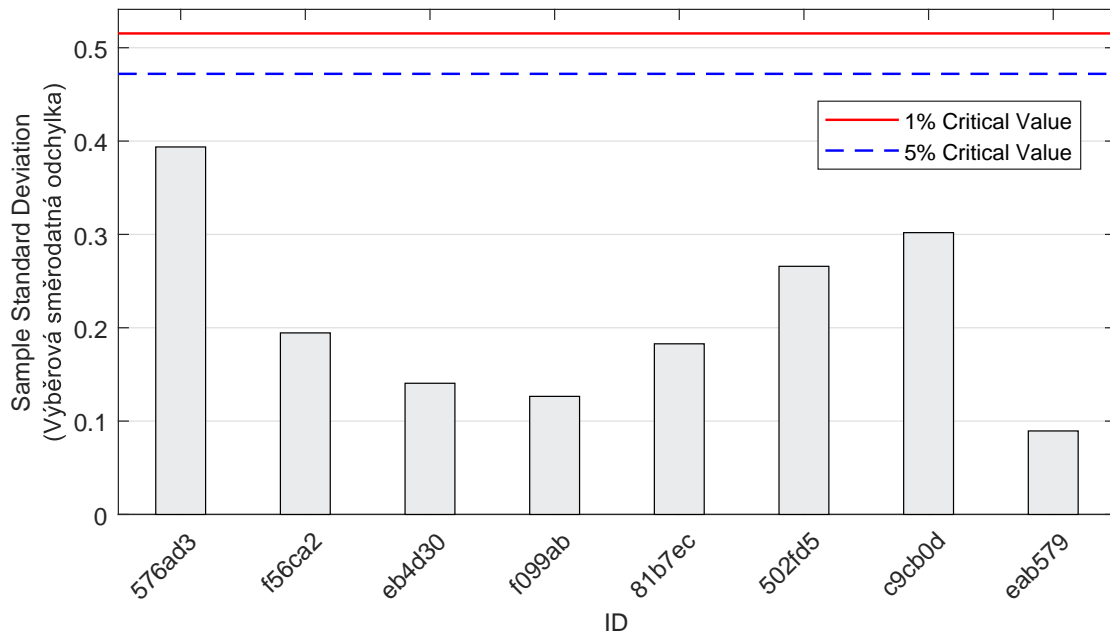

Figure 63: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
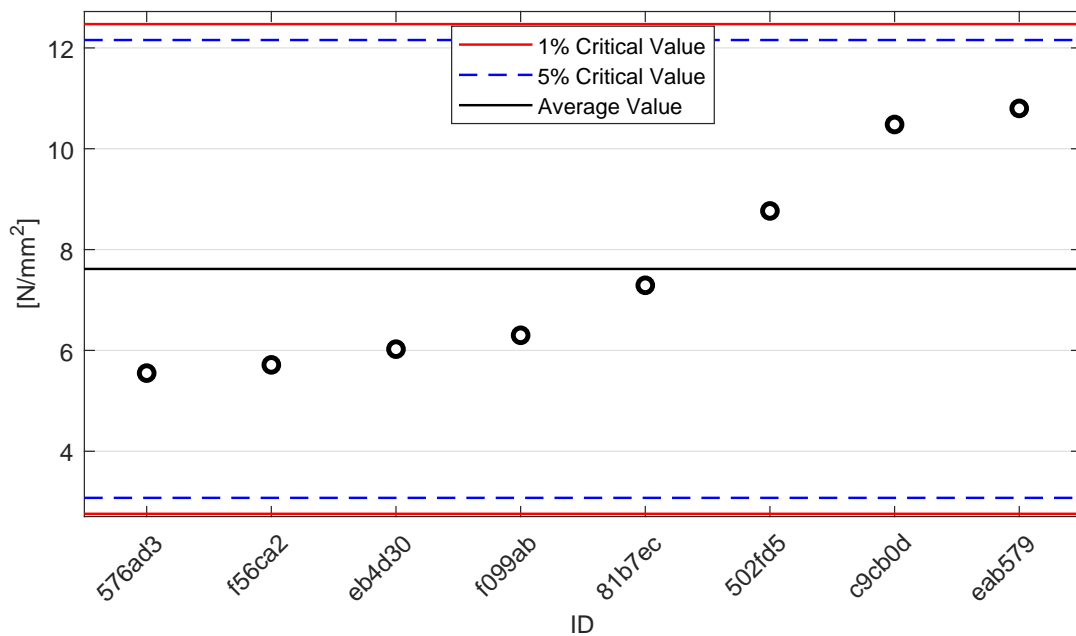

Figure 64: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   48/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz
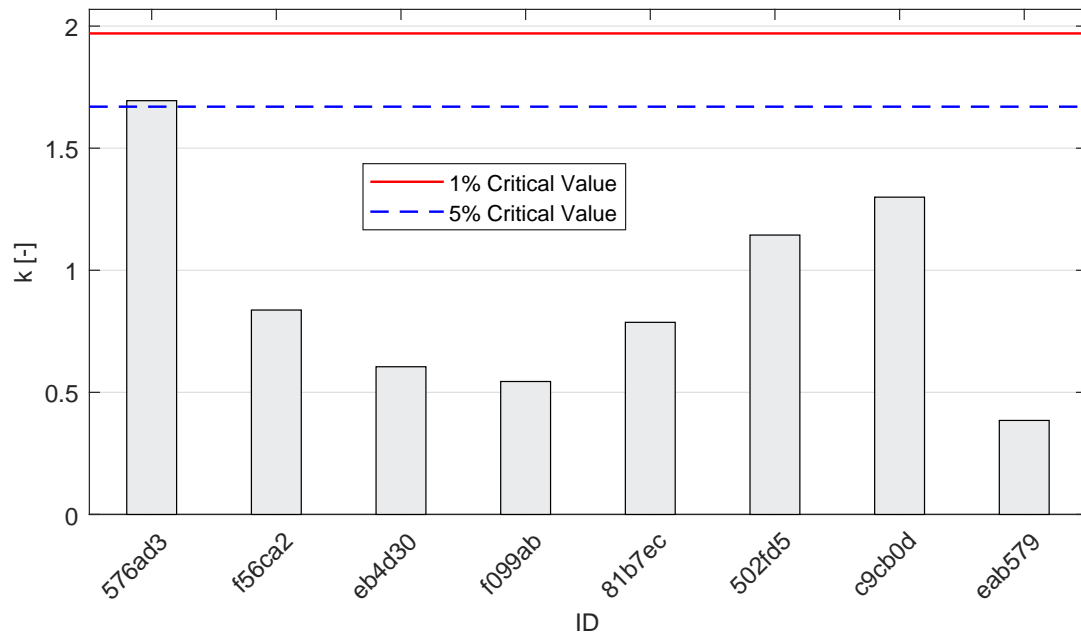
13.2.3   Mandel's Statistics

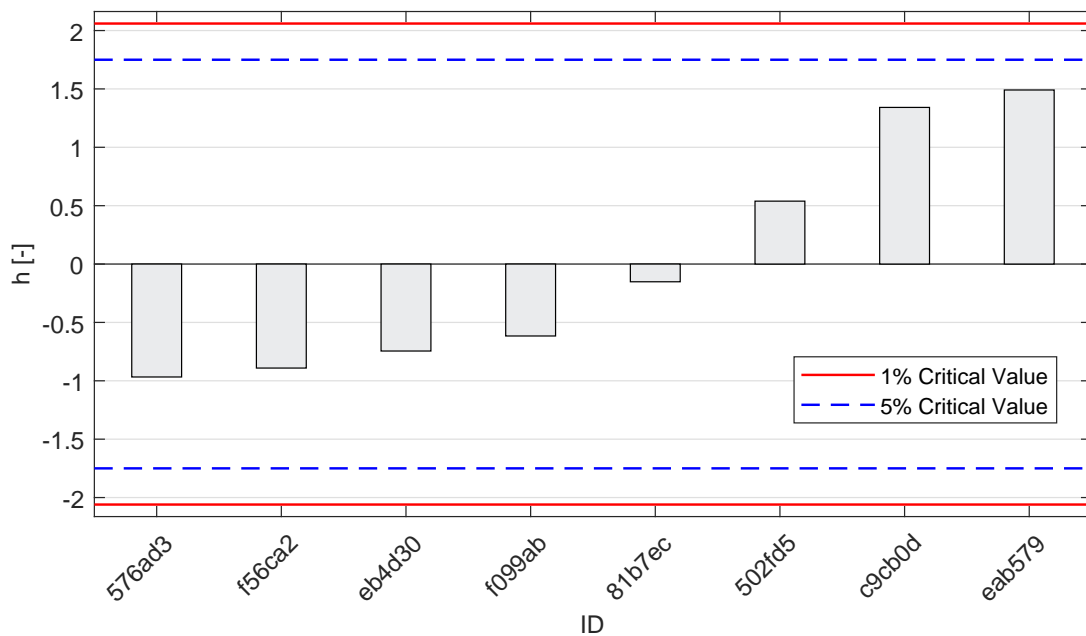Figure 65: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Figure 66: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   49/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
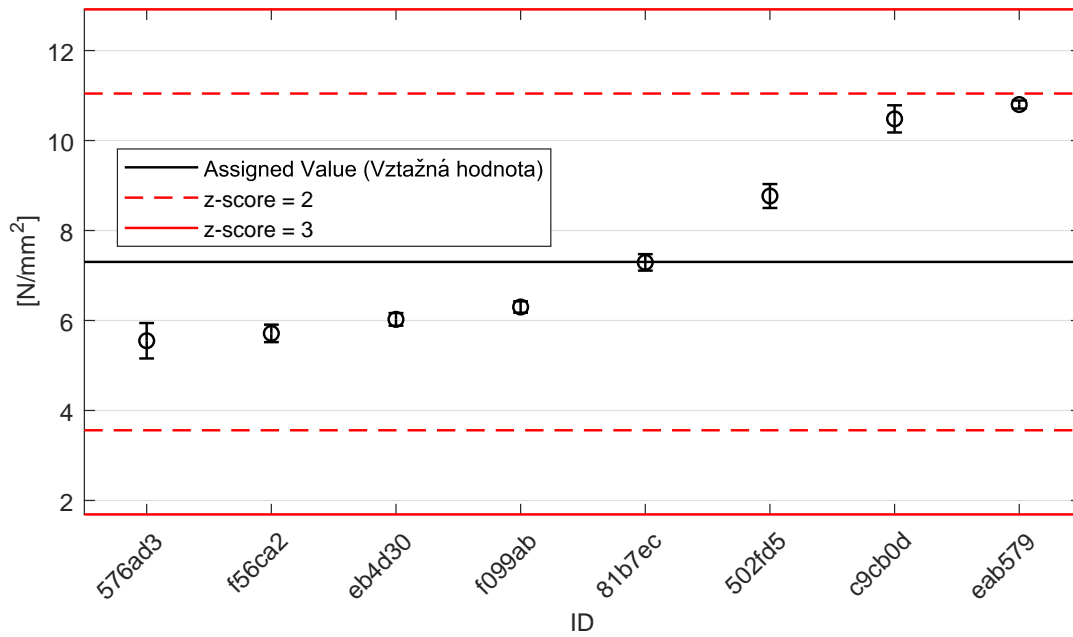szk.fce.vutbr.cz | ptprovider.cz

13.2.4 Calculation of Performance Statistics

Figure 67: Average values and sample standard deviations

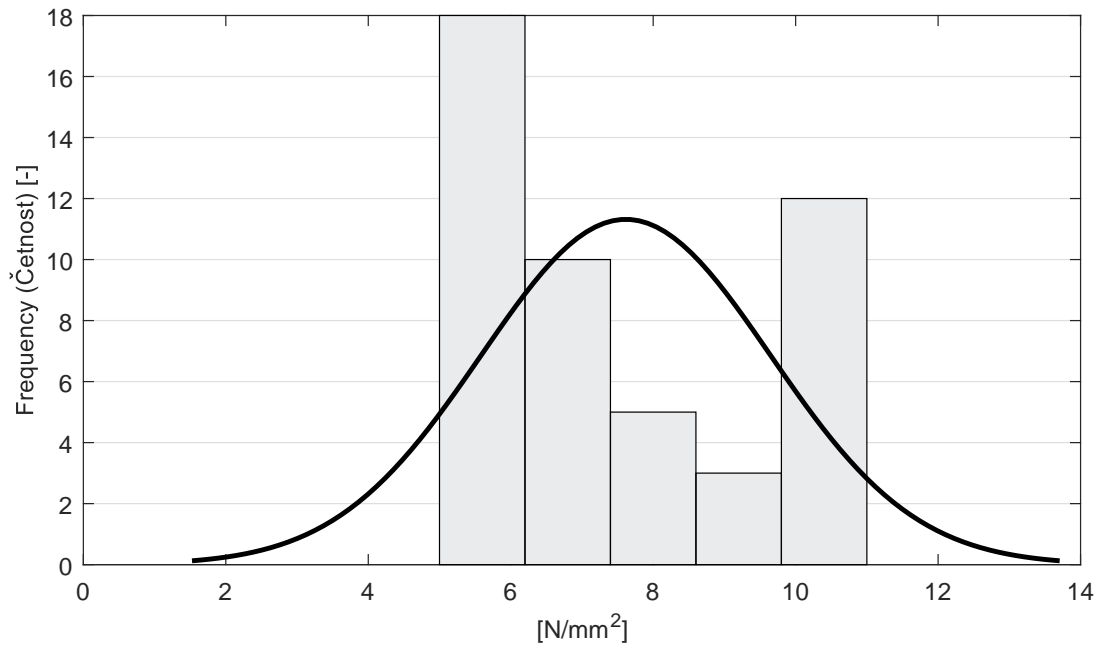Figure 68: Average values and extended uncertainties of measurement

Proficiency Testing Provider at the SZK FAST | Z 7008   50/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Figure 69: Histogram of all test results

Figure 70: z-score and ζ-score

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

51/67

Table 18: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
576ad3	-0.94	-1.91
f56ca2	-0.85	-1.87
eb4d30	-0.68	-1.39
f099ab	-0.54	-1.09
81b7ec	-0.01	-0.01
502fd5	0.78	1.77
c9cb0d	1.70	3.84
eab579	1.87	4.17

14 Appendix – EN 1015-12 – Adhesion

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

15 Appendix – EN 1015-18 – Capillary absorption coeff. (C_m)

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

16 Appendix – EN 1015-19 – Water vapor flow

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

17 Appendix – EN 13892-2 – Tensile strength when bent and compressed

17.1 Flexural Strength

17.1.1 Test results

Table 19: 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 [N/mm^2]			u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
f56ca2	3.3	2.8	2.9	0.1	3.0	0.3	9.05
ed272b	5.7	5.4	5.5	0.3	5.5	0.1	2.41
0fa3f4	6.0	6.2	5.8	0.1	6.0	0.2	3.00
3941ae	6.9	7.2	7.5	0.7	7.2	0.3	3.83
f2bf72	8.3	7.8	8.2	0.3	8.1	0.3	3.27

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

52/67

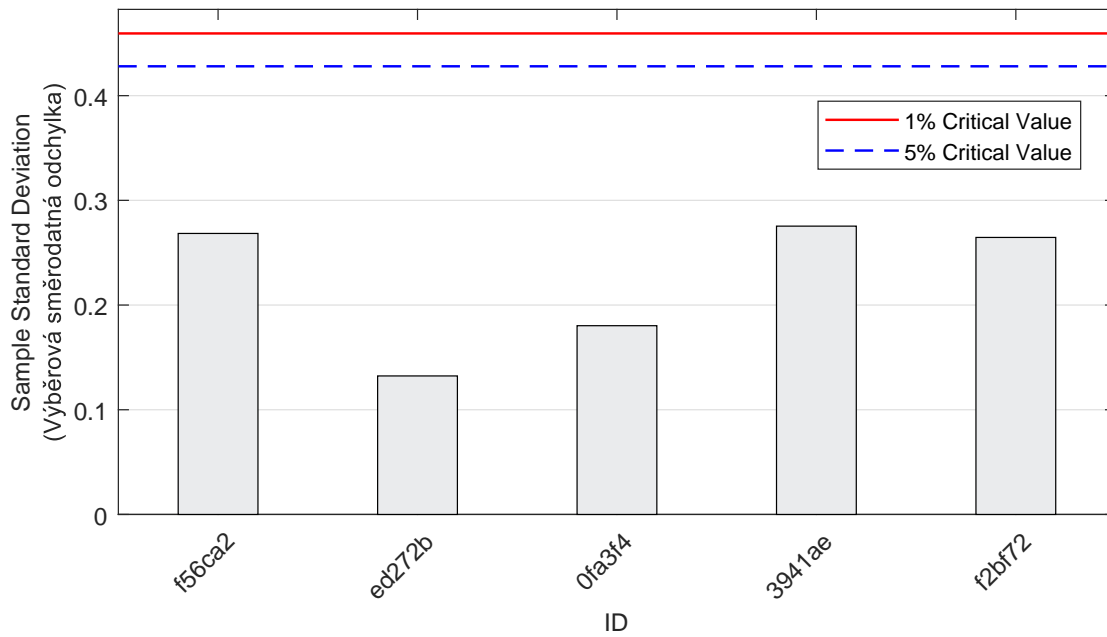### 17.1.2 The Numerical Procedure for Determining Outliers

Figure 71: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
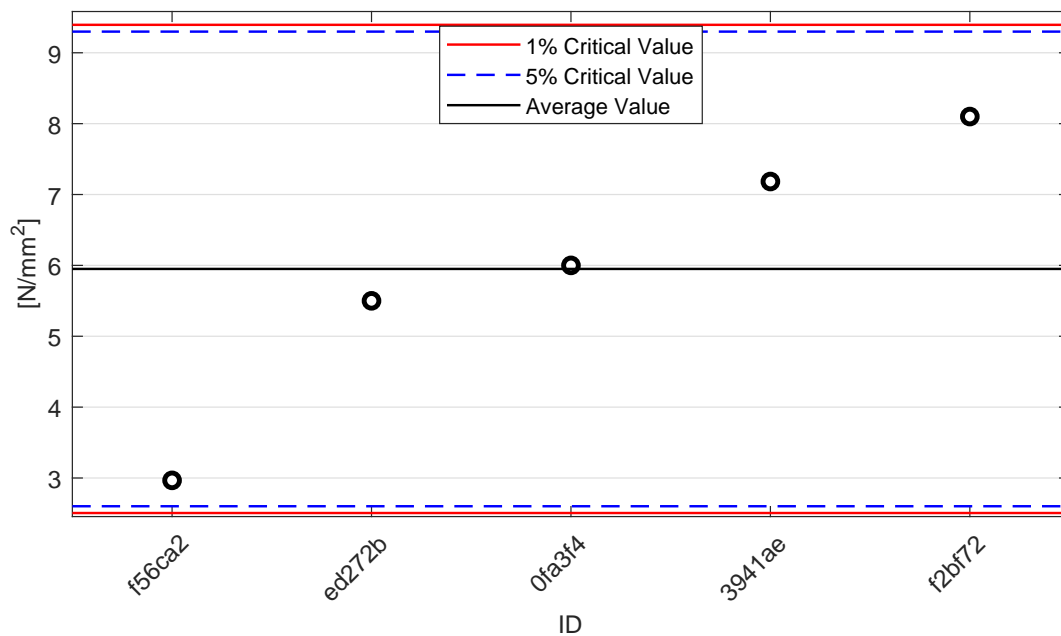

Figure 72: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color
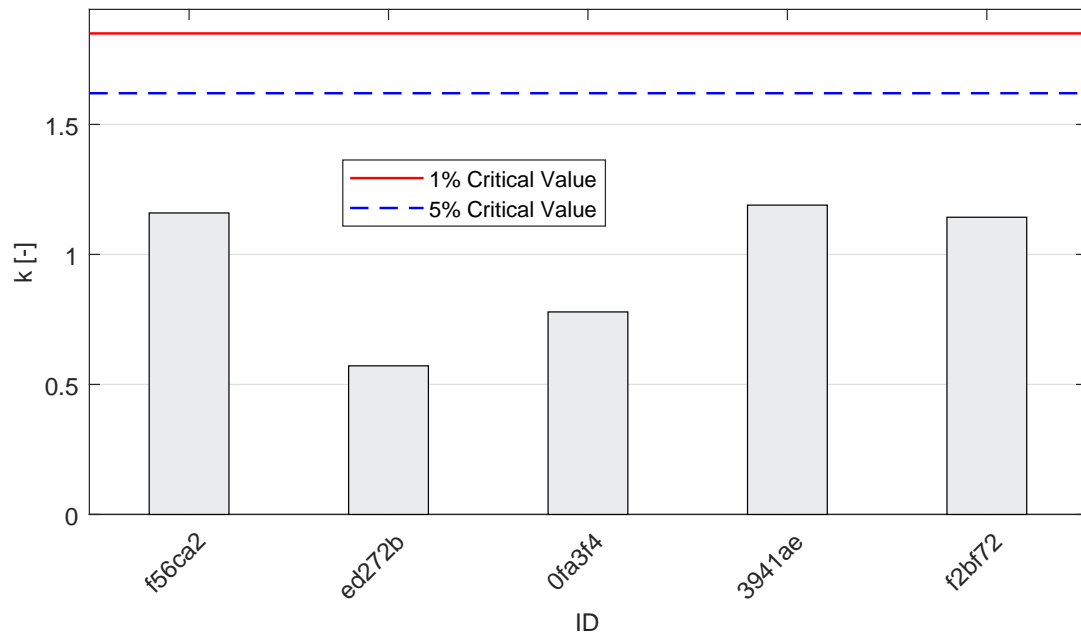
17.1.3 Mandel's Statistics

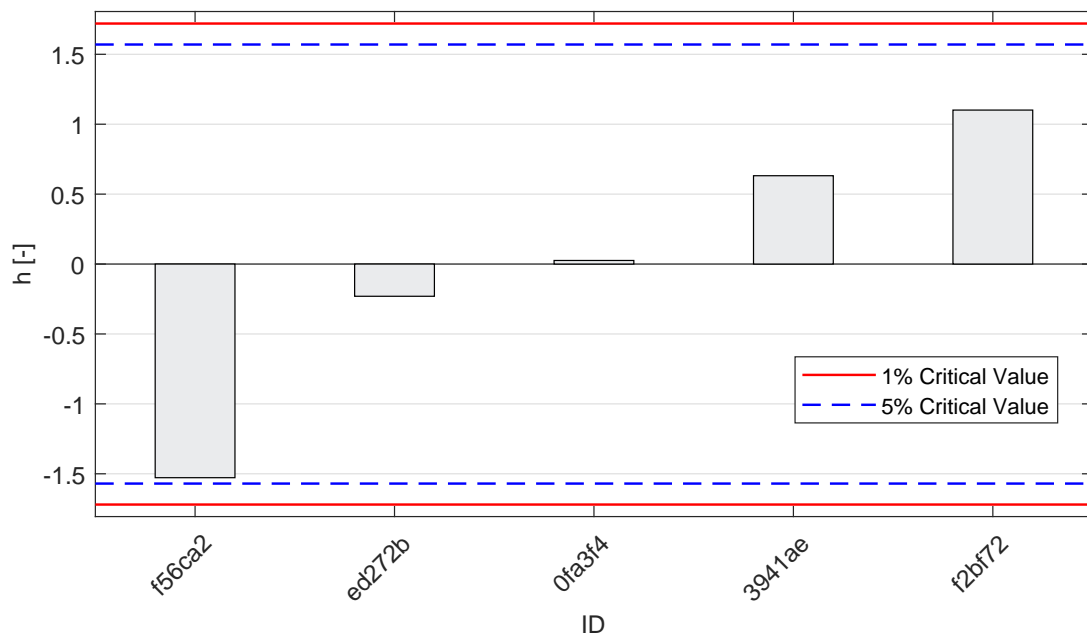Figure 73: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Figure 74: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

54/67

17.1.4 Calculation of Performance Statistics
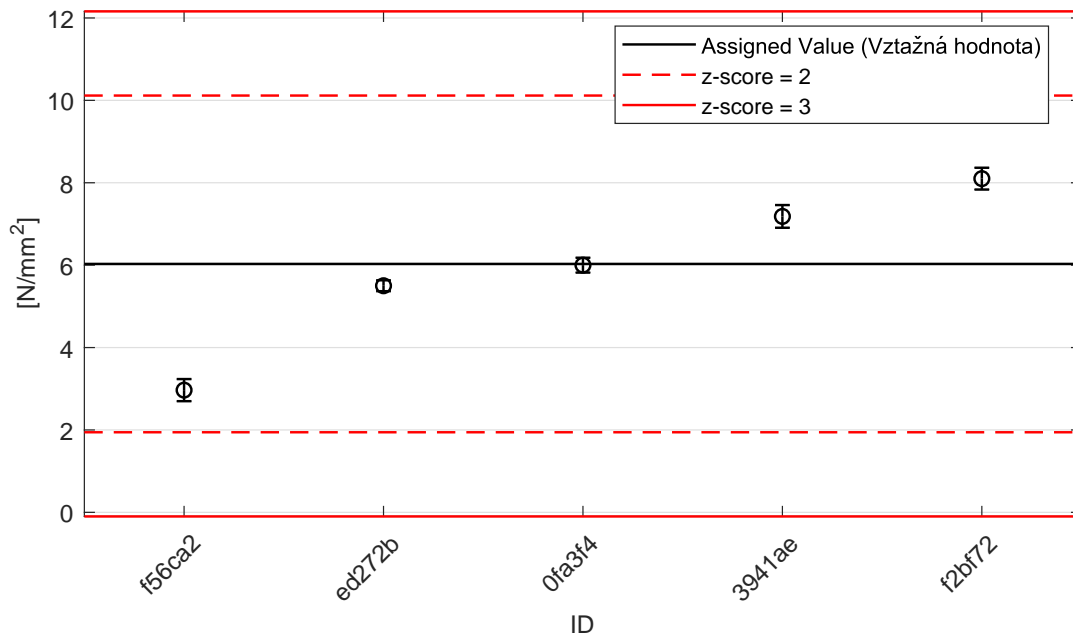

Figure 75: Average values and sample standard deviations

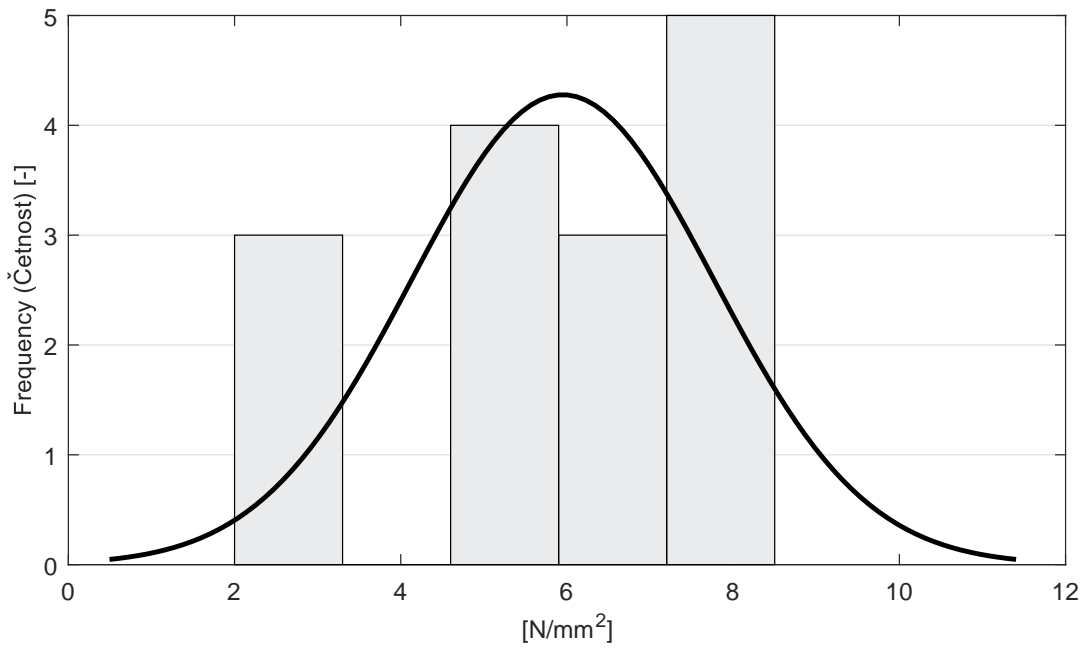Figure 76: Average values and extended uncertainties of measurement

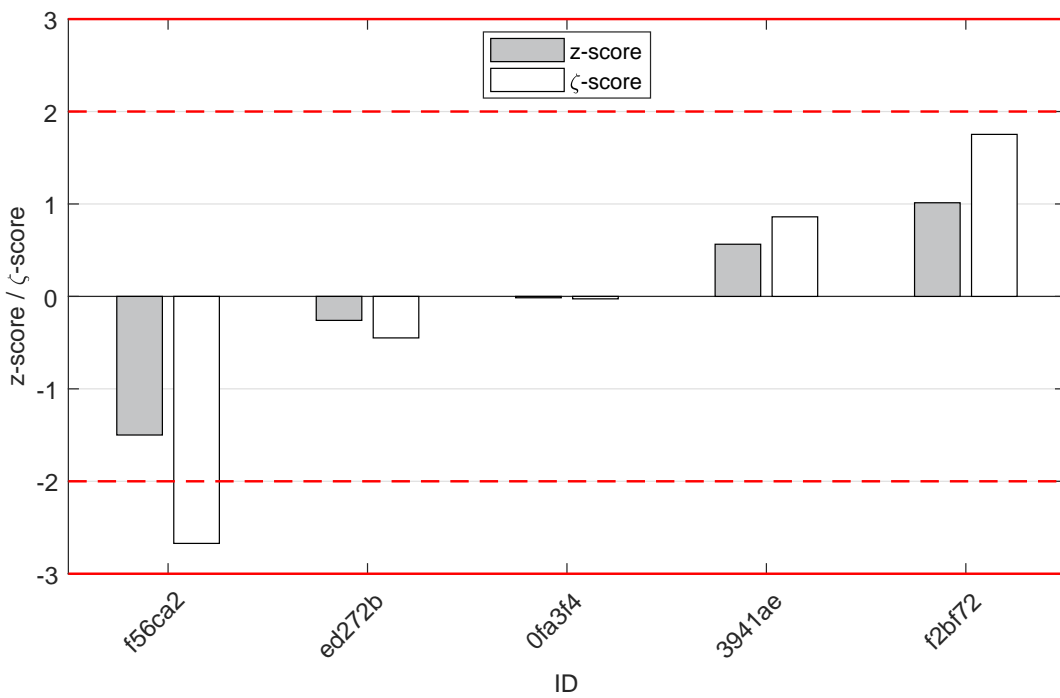Proficiency Testing Provider at the SZK FAST | Z 7008   55/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Figure 77: Histogram of all test results

Figure 78: z-score and ζ-score

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

56/67

Table 20: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f56ca2	-1.50	-2.67
ed272b	-0.26	-0.45
0fa3f4	-0.01	-0.03
3941ae	0.56	0.86
f2bf72	1.01	1.75

17.2 Compressive Strength

17.2.1 Test results

Table 21: 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 [N/mm^2]						u_X [N/mm^2]	$\bar{x}$ [N/mm^2]	s_0 [N/mm^2]	V_X [%]
f56ca2	16.5	15.6	15.3	16.1	15.9	15.6	0.5	15.8	0.4	2.60
ed272b	26.6	25.6	25.9	25.1	25.5	24.9	1.3	25.6	0.6	2.37
3941ae	29.9	29.9	32.2	30.1	29.8	30.9	1.1	30.5	0.9	3.10
0fa3f4	33.8	33.1	35.0	35.0	32.5	32.5	0.4	33.6	1.1	3.40
f2bf72	41.0	40.0	39.2	40.5	39.8	38.4	0.8	39.8	0.9	2.33

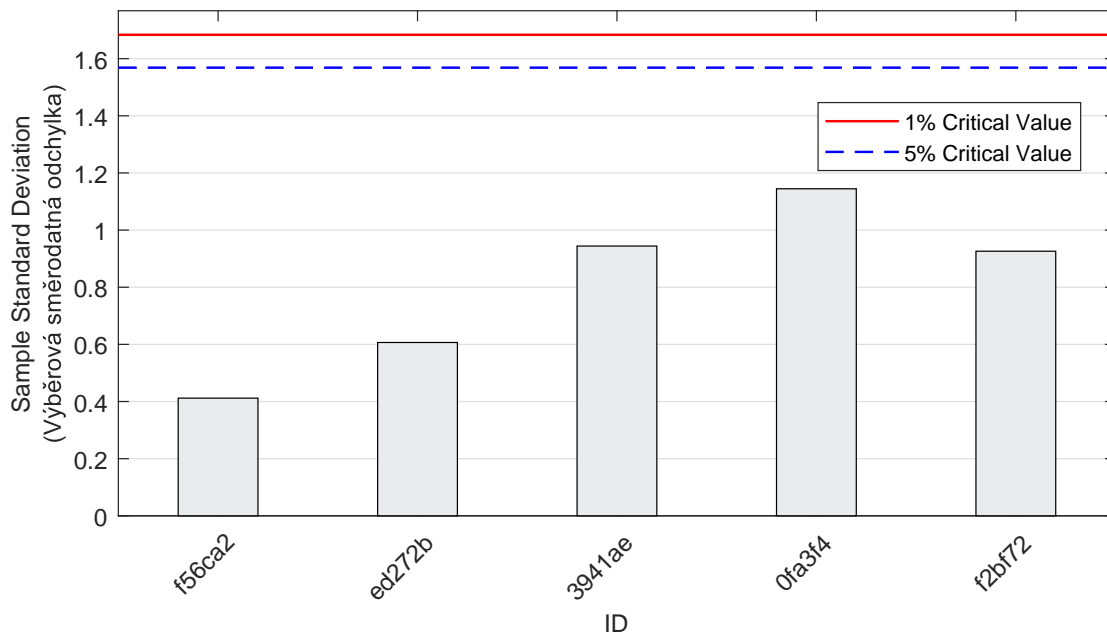### 17.2.2 The Numerical Procedure for Determining Outliers

Figure 79: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color
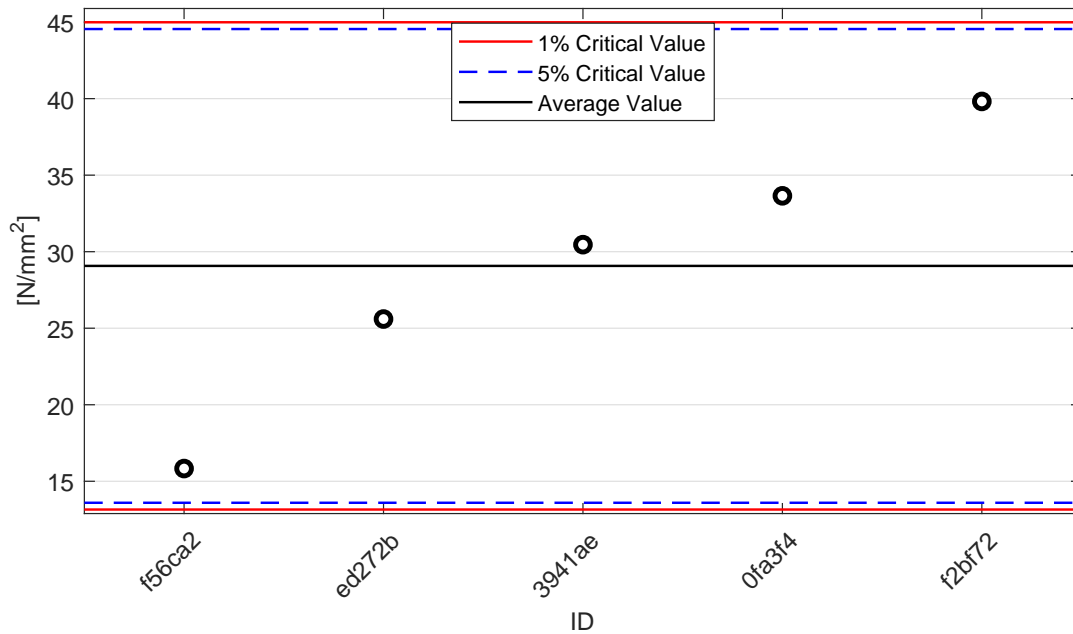
Figure 80: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color
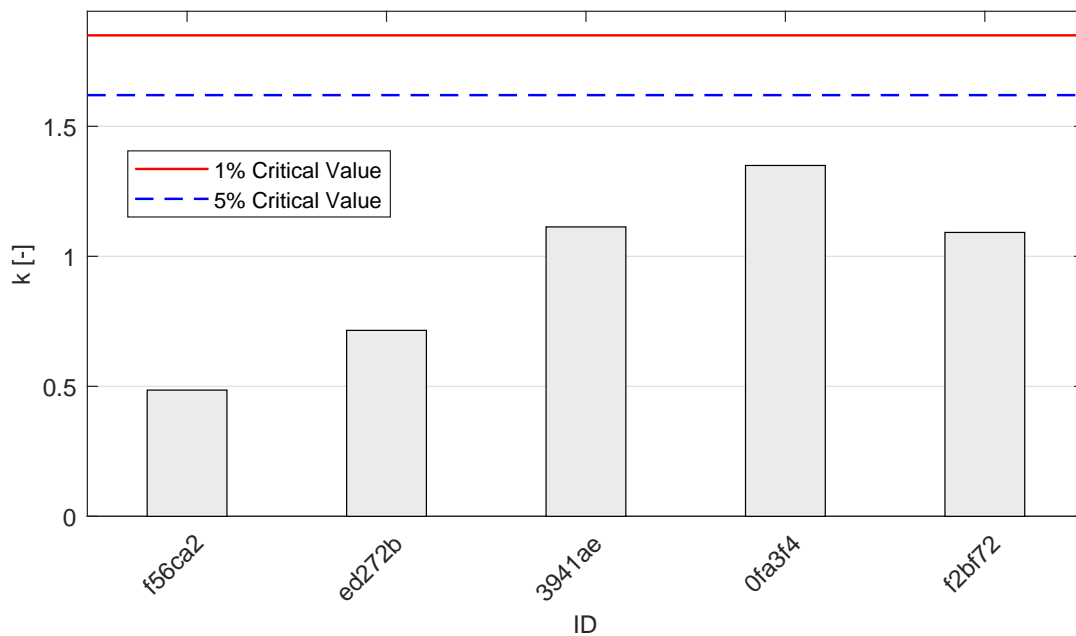
17.2.3   Mandel's Statistics

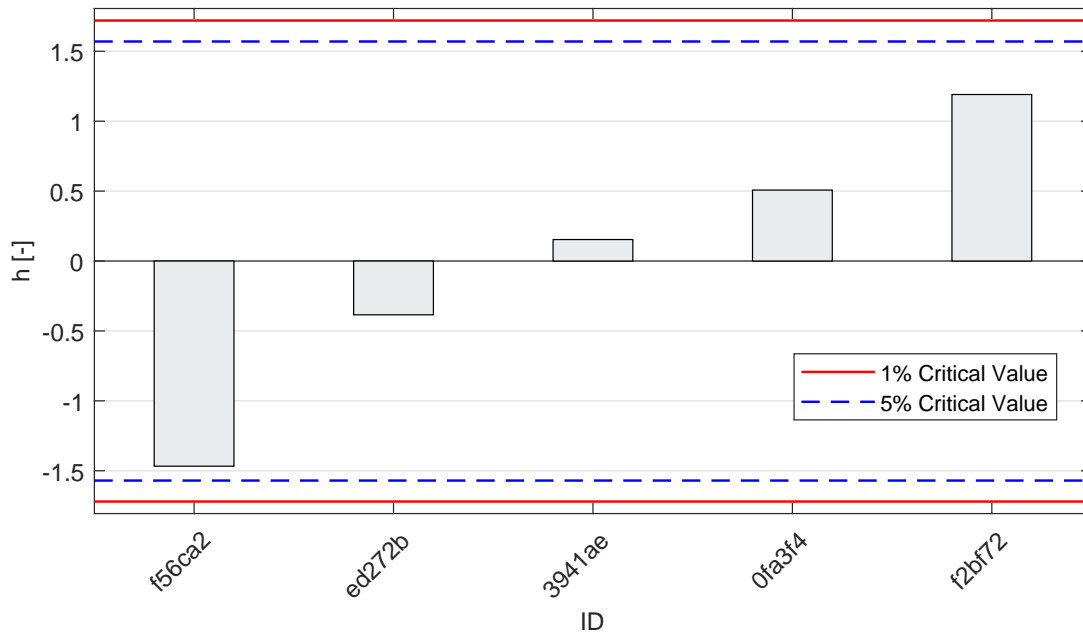Figure 81: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   58/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Figure 82: Interlaboratory Consistency Statistic *h*: 1% critical value - red color; 5% critical value - blue color
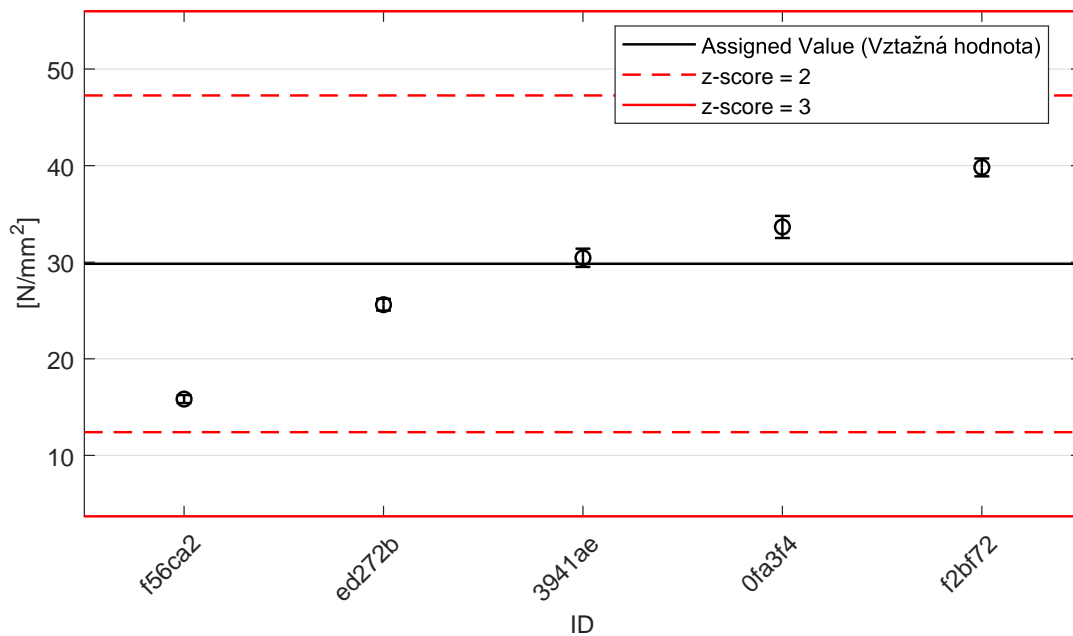
17.2.4   Calculation of Performance Statistics

Figure 83: Average values and sample standard deviations

Proficiency Testing Provider at the SZK FAST | Z 7008   59/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
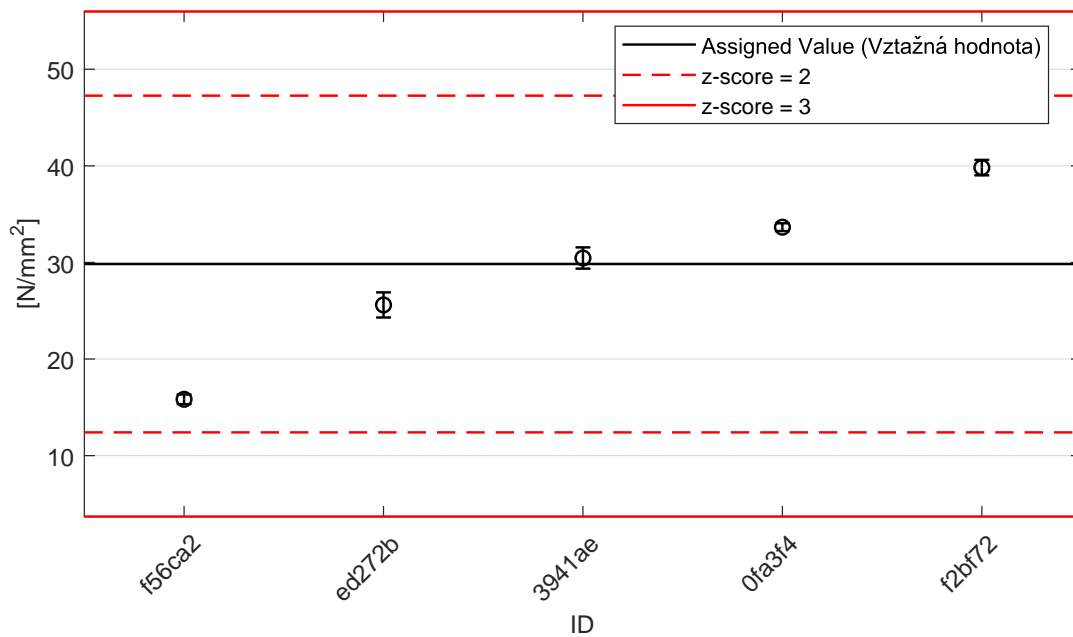szk.fce.vutbr.cz | ptprovider.cz

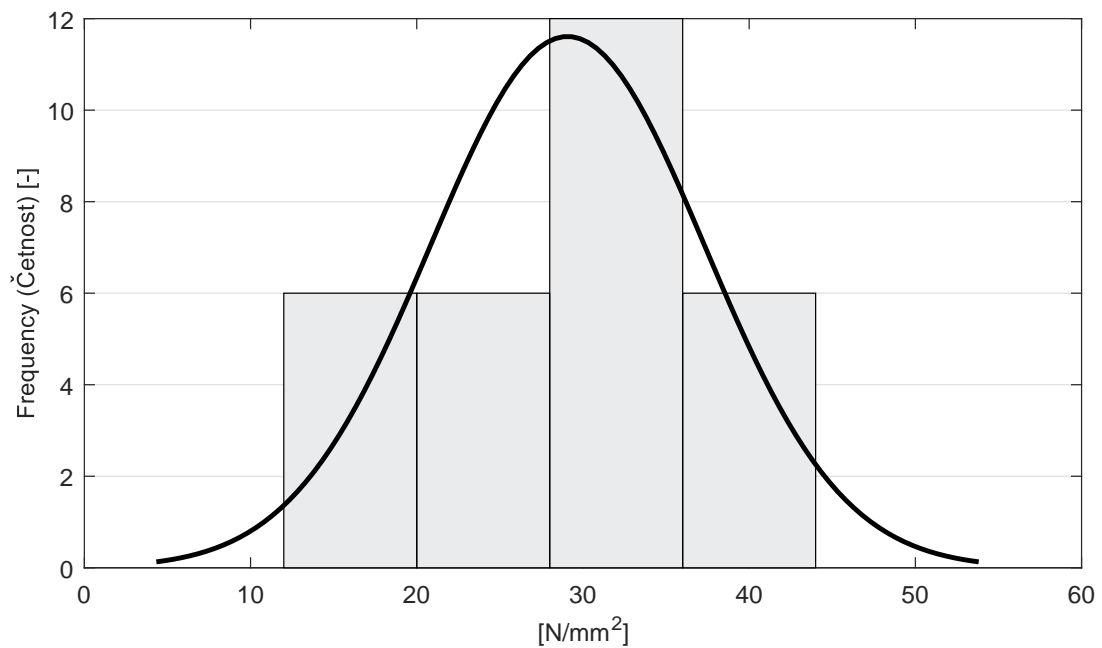Figure 84: Average values and extended uncertainties of measurement
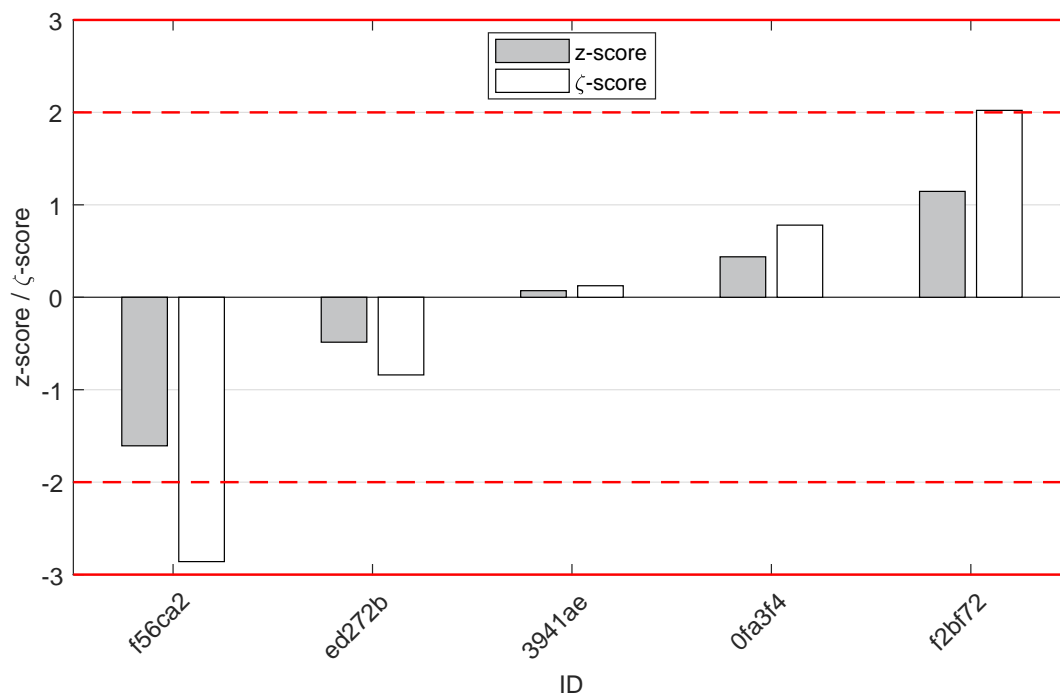

Figure 85: Histogram of all test results

Figure 86: z-score and ζ-score

Table 22: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
f56ca2	-1.61	-2.86
ed272b	-0.49	-0.84
3941ae	0.07	0.12
0fa3f4	0.44	0.78
f2bf72	1.15	2.02

18 Appendix – EN 12004-2, Chapter 8.1 – Open time

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

19 Appendix – EN 12004-2, Chapter 8.2 – Slippage

19.1 Test results

Table 23: 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

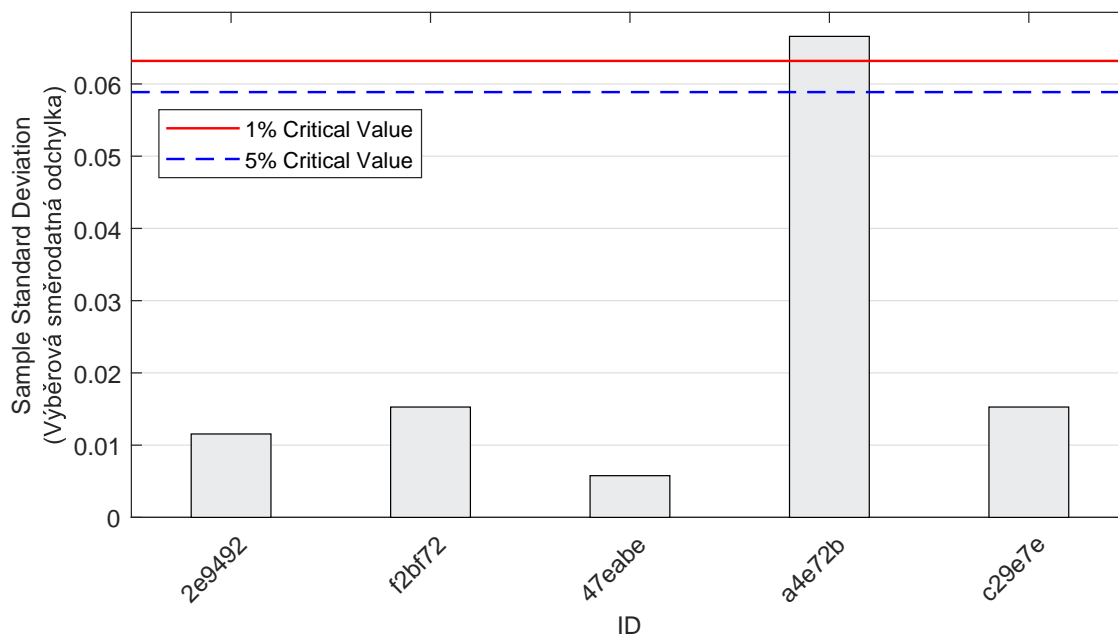| ID of participant	Test results [mm]			u_X [mm]	$\bar{x}$ [mm]	s_0 [mm]	V_X [%]
2e9492	0.09	0.09	0.11	0.01	0.10	0.01	11.95
f2bf72	0.32	0.34	0.35	0.06	0.34	0.02	4.54
47eabe	0.45	0.46	0.45	-	0.45	0.01	1.27
a4e72b	0.57	0.46*	0.58	0.10	0.54	0.07	12.41
c29e7e	0.67	0.70	0.69	0.04	0.69	0.02	2.22

19.2 The Numerical Procedure for Determining Outliers

Figure 87: **Cochran's test** - sample standard deviations: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
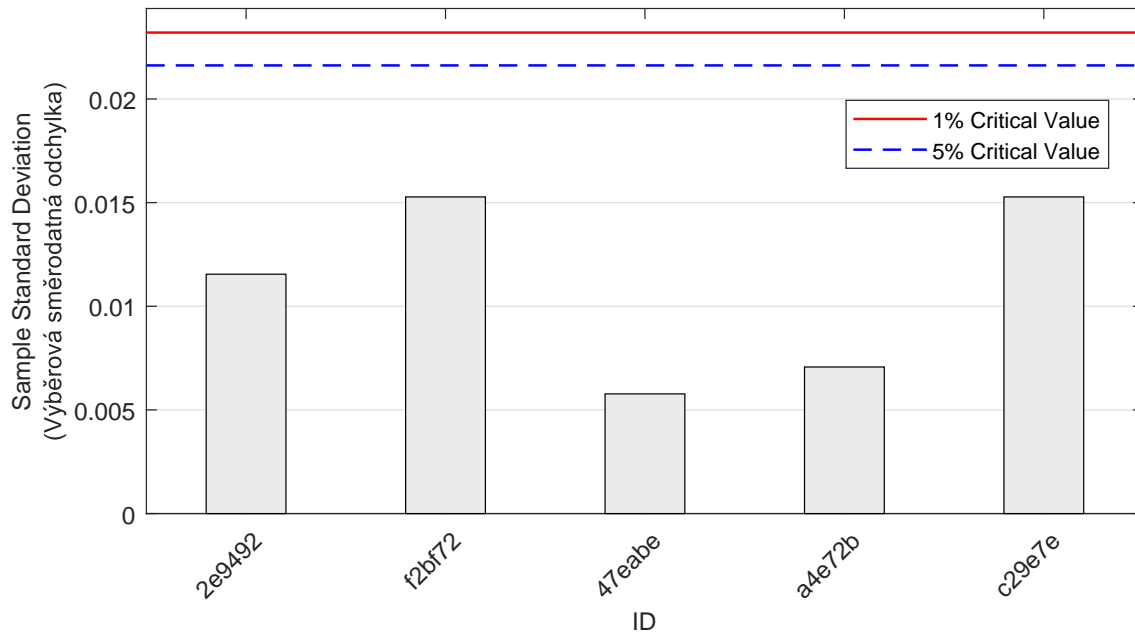szk.fce.vutbr.cz | ptprovider.cz

62/67

Figure 88: **Cochran's test** - sample standard deviations without outliers: 1% critical value - red color; 5% critical value - blue color
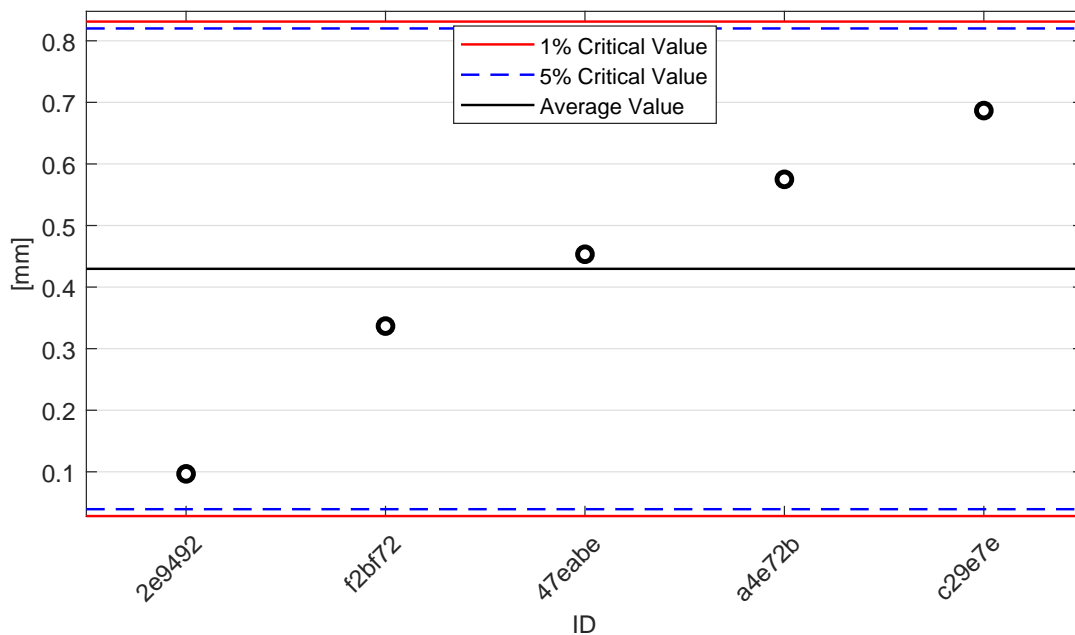

Figure 89: **Grubbs' test** - average values: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz
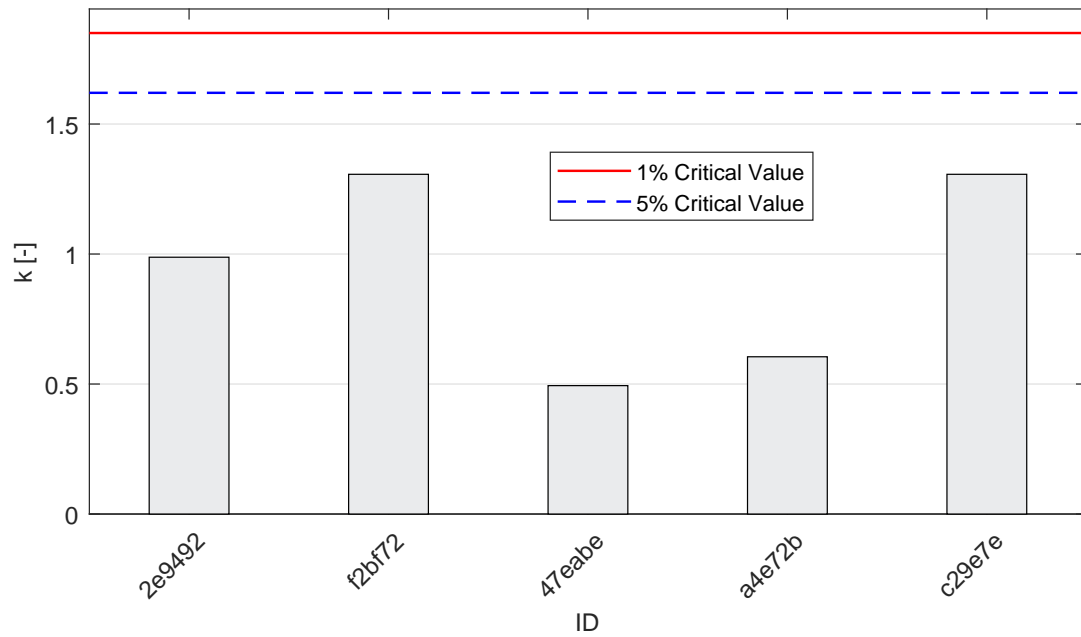
63/67

19.3 Mandel's Statistics

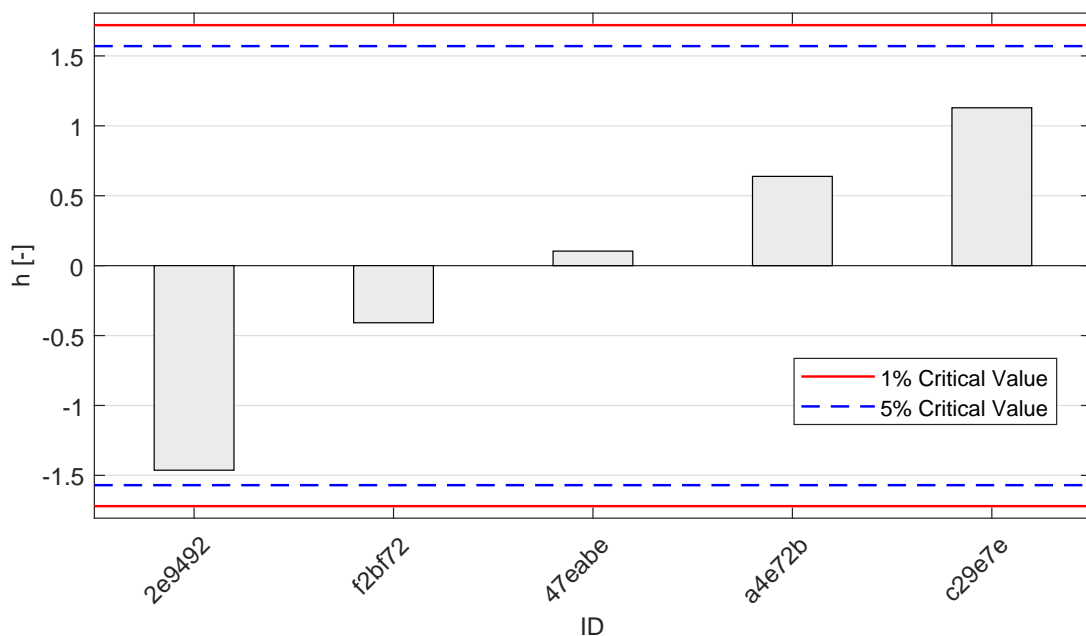Figure 90: Intralaboratory Consistency Statistic k: 1% critical value - red color; 5% critical value - blue color

Figure 91: Interlaboratory Consistency Statistic h: 1% critical value - red color; 5% critical value - blue color

Proficiency Testing Provider at the SZK FAST | Z 7008   64/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

19.4 Calculation of Performance Statistics
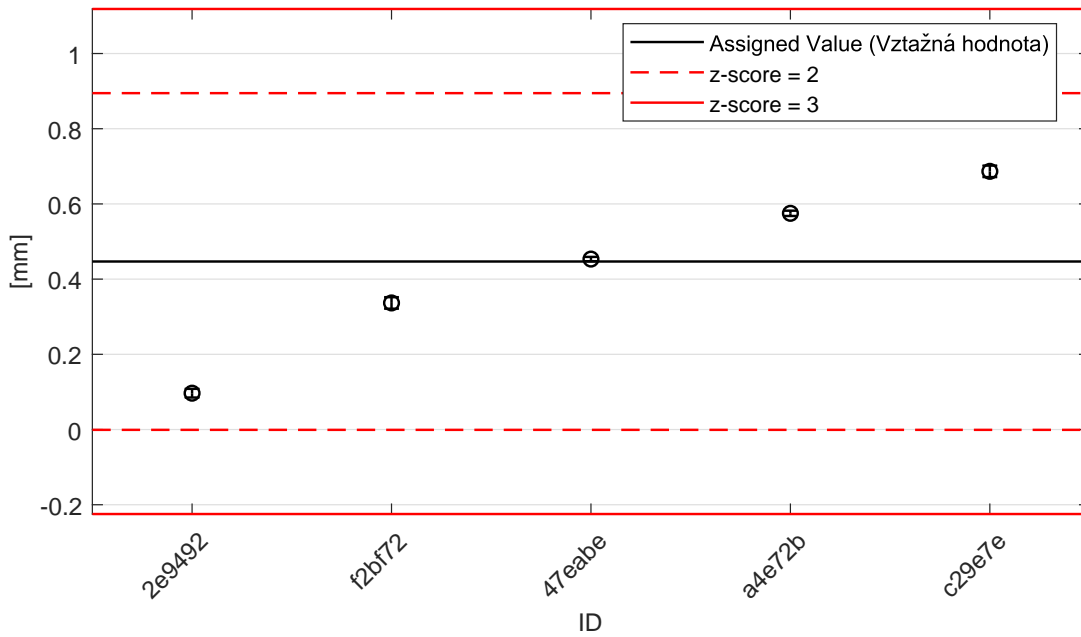

Figure 92: Average values and sample standard deviations

Figure 93: Average values and extended uncertainties of measurement

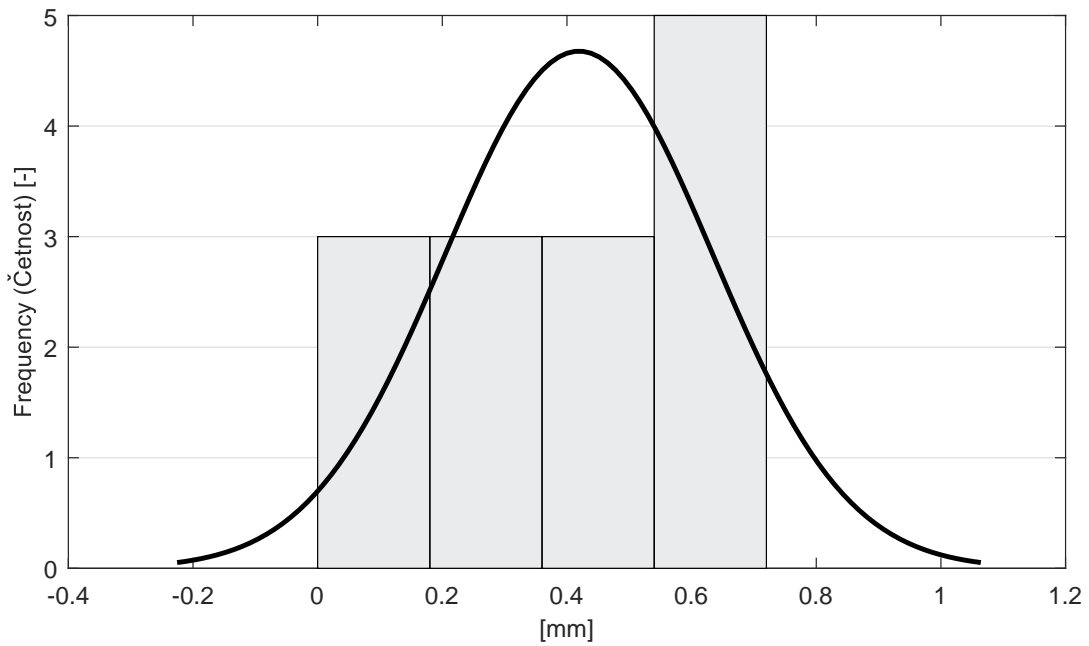Proficiency Testing Provider at the SZK FAST | Z 7008   65/67
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

Figure 94: Histogram of all test results

Figure 95: z-score and ζ-score

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

66/67

Table 24: z-score and ζ-score

ID	z-score [-]	ζ-score [-]
2e9492	-1.56	-2.79
f2bf72	-0.49	-0.79
47eabe	0.03	-
a4e72b	0.57	0.80
c29e7e	1.07	1.83

Proficiency Testing Provider at the SZK FAST | Z 7008
Brno University of Technology | Faculty of Civil Engineering | Departement of Building Testing
Veveří 331/95 | 602 00 Brno | Czech Republic
szk.fce.vutbr.cz | ptprovider.cz

67/67