October 2017

The National Unitary Institution
"Belarusian State Institute of Metrology"
(BelGIM)

SUPPLEMENTARY COMPARISON
COOMET.L- S19
«Comparison of profiles of measuring bridges»

COOMET Project: 658/BY/15
COMPARISONS OF NATIONAL STANDARDS IN THE FIELD OF MEASUREMENTS OFDEVIATIONS FROM STRAIGHTNESS AND FLATNESS

FINAL REPORT

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Introduction

The aim of the project is to determine the degree of equivalence of national measurement standards of Belarus, Russia and Kazakhstan in the field of measurement of straightness and flatness deviations and to support the measurement capabilities claimed by the comparison participants.

The comparison results obtained are presented in Clause 7 of this Report.

1 Comparison participants

Table 1 – Comparison participants

No	NMI	Address	NMI abbreviation	Contact person	E-mail, Telephone, Fax
1	National Unitary Institution "Belarusian State Institute of Metrology"	93, Starovilensky trakt, Minsk, 220053, Republic of Belarus	BelGIM	Vladimir Makarevich	Tel./Fax: +375172392338 E-mail: makarevich@belgim.by
2	Federal State Unitary Enterprise Ural Research Institute for Metrology	4 Krasnoarmeyskaya str., 620000, Yekaterinburg, Russian Federation	UNIIM	Yuriy Shimolin	Tel.: +7 (343) 217 48 59 Fax:: +7 (343) 355 38 17 E-mail: shimolin@uniim.ru
3	South-Kazakhstan Subsidiary of RSE Kazakhstan Institute of Metrology	83 Altynsarina str., 050035 Almaty, Republic of Kazakhstan	SKS RSE KazInMetr	Iryna Suvorova	Tel.: +7 (327) 221 36 16 Fax:+7 (327) 221 65 59 E-mail: metrology@nursat.kz

2 Organization of comparisons

2.1 The comparison principle is as follows: the comparison participants shall make tenfold measurements in 100-mm steps to determine profile straightness deviations of solid-stone bridges maintained at BelGIM, UNIIM and SKS RSE KazInMetr by using measuring instruments being the parts of their respective measurement standards.

2.2 Comparison scheme: round robin.

2.3 Pilot laboratory: BelGIM.

2.4 The comparisons are intended to:

establish the degree of equivalence of measurement standards;

validate the claimed CMC-data.

3 Transfer standards

3.1 During these comparisons, solid-stone bridges included in the national standards of the participant countries were applied as transfer standards. The basic technical characteristics thereof are given in the table 2.

Table 2. Transfer standards

NMI abbreviation	Description of the measuring instrument	Nominal bridge length, *L*	Technical remarks
BelGIM	Solid-stone bridge, special	3 m	permanently installed on isolated footing
UNIIM	Solid-stone bridge, special	5 m	permanently installed on isolated footing
SKS RSE KazInMetr	Solid-stone bridge, special	4 m	permanently installed on isolated footing

Figure 1 – Transfer Standard (BelGIM special solid-stone bridge)

Figure 2 – Transfer Standard (UNIIM special solid-stone bridge)

Figure 3 – Transfer Standard (SKS RSE KazInMetr special solid-stone bridge)

4 Procedure of measurements

4.1 The measurement procedure is based on comparing the real shape of a profile or surface with that of a straight line or surface being reproduced by any available physical method. The physical principle of setting the reference line or surface might be a mechanical, gravitational or optical one.

4.2 When using standard bridges together with measurement systems intended for measuring the bridges' straightness deviations, appropriate instructions for use shall be followed as specified in the relevant operation manuals.

4.3 It is the responsibility of the comparison participants to deliver their measurement systems to the place where the comparison is to be conducted.

4.4 The deviation of the profile from the straight line that connects its extreme points shall be determined stepwise. According to the proposed technique, the difference between the values of the function f(x) describing the profile under investigation shall be determined with respect to the terminal points of an interval the length of which is very small compared with the length of the surface to be measured. In that manner, the average slope of the profile is determined successively (step by step) at its partial sections.

4.5 Prior to performing measurements the standard bridges shall be thoroughly cleaned with alcohol and then wiped by a piece of dry lint-free cloth.

4.6 The deviation of the central section of the bridge working surface from the horizontal plane shall not exceed 0,01 mm/m when measured both longitudinally and transversely. Should the deviations from the horizontal plane be greater than 0,01 mm/m, the positioning of the standard bridge shall be adjusted by appropriately changing the heights of its supports. If so, the measurements are allowed to be performed not earlier than 12 hours after completing the adjustment.

Presence of markings showing the points at which the measurements are to be performed during the comparisons shall be checked. The markings shall be applied at 100 mm intervals. The points shall be numbered sequentially as 0, 1, 2 … N.

4.7 When measuring the straightness deviation using the step-by-step procedure, the surface profile slope shall be determined in succession (in steps) over the intervals $[X_k, X_{k+1}]$, where k=0,1…n-1. For the purpose of further treatment of the observations the origin of the coordinates shall have been aligned with the reference horizontal plane. Then the value of the function f(x) describing the surface profile at the points with X_k, k=0,1,…, n coordinates shall be calculated by totalizing the measured data.

4.8 The determination of the deviation of the profile from the straight line that connects its extreme points shall be performed relative to the central cross-section of the bridge.

4.9 The value of the deviation from the straight line, h_{kj}, μm connecting the profile extreme points at the point k can be obtained by formula

$$h_{kj} = l \cdot (\sum_{i=1}^{k} \vartheta_{ij} - \frac{k}{N} \cdot \sum_{i=1}^{N} \vartheta_{kj}), \qquad (1)$$

where h_{kj} is the deviation from the straight line connecting the extreme profile points at the point k during the j-th measurement, μm ;

l is the distance between the holders of the primary transducers of the measurement systems for measuring the standard, m;

ϑ_i is the reading of the primary transducers of the measurement systems for measuring the standard (slope angle of the surface profile in the i-th section at the j-th measurement), μm/m;

k is the number of the point at the bridge surface where the deviation from the straight line connecting the profile extreme points is being determined;

N is the total number of the measured points at the bridge surface;

j is the specific measurement number.

4.10 The deviation from straightness of the bridge of the measurement standard shall be calculated using the following formula

$$H = h_{\max} + h_{\min}, \qquad (2)$$

where H is the straightness deviation of the measurement standard bridge, μm;

$h_{\max}$ – is the largest absolute value of the positive deviation from the reference straight line over the whole length of the bridge of the measurement standard among all profile points measured, μm;

$h_{\min}$ – is the largest absolute value of the negative deviation from the reference straight line over the whole length of the bridge of the measurement standard among all profile points measured, μm;

5 Ambient conditions during the comparisons

5.1 Ambient conditions at which the straightness deviations of the bridges were measured are stated in Table 3.

Table 3 – Ambient conditions

Name of characteristic	Allowable value
Ambient temperature	(20 ± 2) °C
Relative air humidity	30 % to 70 %
Temperature change rate, max.	0,5 °C/h

6 Short description of measurement standards

6.1 The overall view of the measuring instruments included in the measurement standard of BelGIM is shown in Figure 4.

Figure 4 – Overall view of the measurement system "Electronic level meter WYLER" maintained at BelGIM

6.1.1 The BelGIM measurement system "Electronic level meter WYLER" comprises the following basic equipment manufactured by WYLER (Switzerland):

- electronic gauge MINILEVEL NT No. 262/E0590;
- electronic gauge MINILEVEL NT No. 263/11482;
- level indicating device LEVELMETER 2000 No. E4015;
- software: LEVELSOFT PRO.

6.2 The overall view of the measuring instruments included in the measurement standard of UNIIM is shown in Figure 6.

Figure 5 – Overall view of the measurement system "Electronic level meter WYLER" maintained at UNIIM

6.2.1 The UNIIM measurement system "Electronic level meter WYLER" comprises the following basic equipment manufactured by WYLER (Switzerland):

- electronic gauge BlueLEVEL NT No. Q0894;
- electronic gauge BlueLEVEL NT No. Q0895;
- electronic gauge BlueLEVEL NT No. Q0896;
- electronic gauge BlueLEVEL NT No. Q0897;
- level indicating device BlueMETER SIGMA No. Q1007;
- level indicating device BlueMETER SIGMA No. Q1008;

- software: LEVELSOFT PRO.

6.3 The overall view of the measuring instruments included in the measurement standard of SKS RSE KazInMetr is shown in Figure 5.

Figure 6 – Overall view of the measurement system "Electronic level meter WYLER" maintained at SKS RSE KazInMetr

6.3.1 The SKS RSE KazInMetr measurement system "Electronic level meter WYLER" comprises the following basic equipment manufactured by WYLER (Switzerland):

- electronic gauge MINILEVEL NT No. G0748;
- electronic gauge MINILEVEL NT No. L0765;
- level indicating device LEVELMETER 2000 No. G04211;
- software: LEVELSOFT PRO.

7 Comparison results

7.1 Determining the values of the deviation from the straight line connecting the extreme points of the bridge profiles

Mathematical treatment of the measurement results obtained in the angle units to determine the values of the straightness deviations was performed in accordance with Formulae (1, 2). The measurement results were processed in the Microsoft Excel program. The outcomes of the calculations are given in Tables 4-12.

7.1.1 Determination of the values of the deviation from the straight line connecting the extreme points of the BelGIM bridge profile

Table 4 - The deviation from the straight line connecting the extreme points of the BelGIM bridge profile at each point of the bridge, obtained by means of the dedicated measuring system of BelGIM

in µm

Point number	Deviation from the line connecting the extreme profile points for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	-1,10	-1,06	-1,10	-0,99	-0,97	-1,16	-1,09	-1,15	-1,10	-1,00	-1,07	0,02
2	-2,01	-1,97	-2,06	-1,86	-1,89	-2,18	-1,99	-2,15	-2,05	-1,87	-2,00	0,04

Point number	Deviation from the line connecting the extreme profile points for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
3	-2,84	-2,79	-2,93	-2,68	-2,70	-3,10	-2,81	-3,05	-2,91	-2,67	-2,85	0,05
4	-4,25	-4,16	-4,35	-4,04	-4,06	-4,54	-4,19	-4,50	-4,31	-4,01	-4,24	0,06
5	-5,55	-5,41	-5,64	-5,32	-5,29	-5,85	-5,45	-5,88	-5,68	-5,27	-5,53	0,07
6	-6,05	-5,79	-6,07	-5,68	-5,67	-6,26	-5,82	-6,31	-6,09	-5,64	-5,94	0,08
7	-6,05	-5,75	-6,05	-5,62	-5,65	-6,24	-5,78	-6,35	-6,07	-5,60	-5,91	0,09
8	-5,60	-5,22	-5,51	-5,10	-5,13	-5,75	-5,27	-5,85	-5,57	-5,05	-5,41	0,09
9	-4,55	-4,06	-4,39	-4,03	-3,98	-4,65	-4,11	-4,75	-4,43	-3,92	-4,29	0,10
10	-3,61	-3,02	-3,36	-3,04	-3,00	-3,69	-3,08	-3,71	-3,42	-2,91	-3,28	0,10
11	-2,87	-2,21	-2,58	-2,25	-2,22	-2,85	-2,25	-2,92	-2,59	-2,08	-2,48	0,10
12	-2,36	-1,70	-2,04	-1,74	-1,66	-2,28	-1,71	-2,36	-2,04	-1,52	-1,94	0,10
13	-2,17	-1,50	-1,82	-1,57	-1,46	-2,09	-1,46	-2,13	-1,84	-1,32	-1,74	0,10
14	-2,21	-1,48	-1,81	-1,56	-1,43	-2,08	-1,43	-2,09	-1,83	-1,35	-1,73	0,10
15	-2,34	-1,61	-1,97	-1,70	-1,59	-2,20	-1,55	-2,21	-2,01	-1,52	-1,87	0,10
16	-2,31	-1,52	-1,88	-1,64	-1,53	-2,14	-1,45	-2,10	-1,92	-1,48	-1,80	0,10
17	-2,28	-1,50	-1,86	-1,65	-1,55	-2,14	-1,42	-2,06	-1,89	-1,49	-1,78	0,10
18	-2,26	-1,44	-1,82	-1,65	-1,53	-2,09	-1,37	-2,00	-1,86	-1,48	-1,75	0,10
19	-2,36	-1,56	-1,91	-1,80	-1,65	-2,18	-1,51	-2,08	-1,94	-1,62	-1,86	0,09
20	-2,57	-1,83	-2,18	-2,09	-1,93	-2,42	-1,75	-2,32	-2,20	-1,92	-2,12	0,08
21	-2,73	-2,03	-2,34	-2,28	-2,13	-2,59	-1,94	-2,50	-2,38	-2,15	-2,31	0,08
22	-2,82	-2,15	-2,44	-2,40	-2,23	-2,66	-2,07	-2,55	-2,49	-2,27	-2,41	0,07
23	-2,89	-2,25	-2,52	-2,52	-2,34	-2,70	-2,19	-2,63	-2,60	-2,34	-2,50	0,07
24	-2,85	-2,27	-2,47	-2,55	-2,34	-2,68	-2,23	-2,57	-2,63	-2,34	-2,49	0,06
25	-2,82	-2,29	-2,44	-2,57	-2,37	-2,67	-2,27	-2,53	-2,62	-2,40	-2,50	0,06
26	-2,69	-2,22	-2,33	-2,50	-2,29	-2,53	-2,17	-2,42	-2,52	-2,36	-2,40	0,05
27	-2,40	-1,94	-2,08	-2,27	-2,06	-2,24	-1,95	-2,11	-2,24	-2,12	-2,14	0,05
28	-1,88	-1,57	-1,65	-1,80	-1,67	-1,77	-1,55	-1,66	-1,74	-1,70	-1,70	0,03
29	-1,12	-0,93	-0,99	-0,88	-1,00	-1,03	-0,94	-0,98	-1,03	-1,00	-0,99	0,02
30	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h_{max}	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-
h_{min}	-6,05	-5,79	-6,07	-5,68	-5,67	-6,26	-5,82	-6,35	-6,09	-5,64	-5,94	-
H	6,05	5,79	6,07	5,68	5,67	6,26	5,82	6,35	6,09	5,64	**5,94**	0,08

Table 5 - The deviation from the straight line connecting the extreme points of the BelGIM bridge profile at each point of the bridge, obtained by means of the dedicated measuring system of UNIIM

in µm

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	-0,71	-0,87	-0,82	-0,87	-0,79	-0,92	-0,90	-0,85	-0,72	-0,63	-0,81	0,03
2	-1,68	-1,67	-1,67	-1,73	-1,71	-1,80	-1,70	-1,72	-1,54	-1,48	-1,67	0,03
3	-2,61	-2,40	-2,40	-2,50	-2,59	-2,57	-2,55	-2,51	-2,34	-2,30	-2,48	0,03
4	-4,17	-3,99	-4,05	-4,13	-4,22	-4,23	-4,25	-4,16	-3,92	-3,92	-4,10	0,04
5	-5,48	-5,25	-5,36	-5,35	-5,56	-5,50	-5,47	-5,42	-5,17	-5,18	-5,37	0,04
6	-6,04	-5,65	-5,83	-5,77	-6,06	-6,01	-6,02	-5,89	-5,60	-5,66	-5,85	0,06
7	-6,08	-5,64	-5,83	-5,82	-6,14	-6,10	-6,10	-5,93	-5,60	-5,72	-5,90	0,06
8	-5,59	-5,14	-5,31	-5,31	-5,64	-5,57	-5,60	-5,41	-5,01	-5,22	-5,38	0,07
9	-4,72	-4,22	-4,31	-4,30	-4,70	-4,58	-4,68	-4,45	-4,02	-4,09	-4,41	0,08
10	-3,76	-3,23	-3,35	-3,29	-3,75	-3,63	-3,75	-3,49	-3,04	-3,18	-3,45	0,08
11	-3,01	-2,49	-2,60	-2,50	-2,99	-2,94	-3,02	-2,70	-2,26	-2,42	-2,69	0,09
12	-2,49	-2,03	-2,06	-1,98	-2,54	-2,49	-2,56	-2,24	-1,75	-1,91	-2,21	0,09

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
13	-2,33	-1,84	-1,86	-1,80	-2,35	-2,37	-2,42	-2,11	-1,60	-1,77	-2,04	0,10
14	-2,34	-1,86	-1,85	-1,80	-2,36	-2,40	-2,43	-2,16	-1,64	-1,77	-2,06	0,10
15	-2,51	-2,02	-1,99	-1,95	-2,50	-2,52	-2,54	-2,33	-1,82	-1,91	-2,21	0,09
16	-2,55	-2,04	-2,05	-2,00	-2,52	-2,54	-2,53	-2,38	-1,87	-1,93	-2,24	0,09
17	-2,57	-2,07	-2,07	-2,01	-2,54	-2,53	-2,46	-2,41	-1,90	-1,88	-2,24	0,09
18	-2,57	-2,02	-2,06	-1,96	-2,50	-2,54	-2,42	-2,39	-1,96	-1,82	-2,22	0,09
19	-2,62	-2,07	-2,18	-2,06	-2,55	-2,61	-2,53	-2,49	-2,08	-1,92	-2,31	0,09
20	-2,85	-2,29	-2,45	-2,30	-2,76	-2,86	-2,77	-2,73	-2,36	-2,14	-2,55	0,09
21	-2,93	-2,41	-2,62	-2,43	-2,86	-2,97	-2,88	-2,82	-2,49	-2,23	-2,66	0,08
22	-3,02	-2,54	-2,79	-2,57	-2,98	-3,10	-3,01	-2,94	-2,66	-2,37	-2,80	0,08
23	-2,99	-2,66	-2,85	-2,64	-3,03	-3,08	-3,07	-2,94	-2,71	-2,39	-2,84	0,07
24	-3,11	-2,83	-3,00	-2,80	-3,14	-3,21	-3,17	-3,04	-2,77	-2,56	-2,96	0,07
25	-3,10	-2,84	-2,99	-2,84	-3,12	-3,20	-3,16	-3,03	-2,75	-2,62	-2,96	0,06
26	-2,89	-2,70	-2,82	-2,67	-2,91	-2,96	-2,90	-2,85	-2,53	-2,50	-2,78	0,05
27	-2,45	-2,29	-2,42	-2,29	-2,49	-2,51	-2,48	-2,44	-2,18	-2,20	-2,38	0,04
28	-1,93	-1,83	-1,92	-1,83	-1,96	-2,00	-1,95	-1,89	-1,71	-1,75	-1,88	0,03
29	-1,11	-1,06	-1,13	-1,04	-1,13	-1,17	-1,12	-1,12	-1,02	-1,04	-1,09	0,02
30	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h_{max}	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-
h_{min}	-6,08	-5,65	-5,83	-5,82	-6,14	-6,10	-6,10	-5,93	-5,60	-5,72	-5,90	-
H	6,08	5,65	5,83	5,82	6,14	6,10	6,10	5,93	5,60	5,72	**5,90**	0,06

Table 6 - The deviation from the straight line connecting the extreme points of the BelGIM bridge profile at each point of the bridge, obtained by means of the dedicated measuring system of SKS RSE KazInMetr

in µm

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	-1,11	-0,99	-1,10	-1,03	-1,13	-1,14	-1,10	-0,96	-1,03	-1,05	-1,06	0,02
2	-2,08	-1,85	-2,05	-1,87	-2,11	-2,08	-2,00	-1,83	-1,90	-1,94	-1,97	0,03
3	-2,94	-2,61	-2,87	-2,65	-2,91	-2,92	-2,81	-2,62	-2,65	-2,72	-2,77	0,04
4	-4,39	-3,93	-3,65	-4,09	-4,28	-4,32	-4,19	-3,99	-4,07	-4,12	-4,10	0,07
5	-5,66	-5,14	-4,96	-5,29	-5,54	-5,59	-5,44	-5,25	-5,32	-5,35	-5,35	0,07
6	-6,10	-5,49	-5,36	-5,66	-5,95	-5,97	-5,83	-5,63	-5,69	-5,73	-5,74	0,07
7	-6,09	-5,39	-5,28	-5,59	-5,94	-5,92	-5,77	-5,69	-5,61	-5,68	-5,70	0,08
8	-5,58	-4,79	-4,75	-5,01	-5,38	-5,42	-5,24	-5,16	-5,04	-5,15	-5,15	0,08
9	-4,48	-3,63	-3,64	-3,82	-4,25	-4,31	-4,11	-4,06	-3,91	-4,06	-4,03	0,09
10	-3,52	-2,59	-2,66	-2,82	-3,30	-3,33	-3,14	-3,00	-2,92	-3,07	-3,03	0,09
11	-2,73	-1,77	-1,85	-1,95	-2,52	-2,51	-2,34	-2,21	-2,08	-2,30	-2,23	0,10
12	-2,26	-1,24	-1,34	-1,47	-1,99	-1,99	-1,82	-1,64	-1,55	-1,82	-1,71	0,10
13	-2,10	-1,04	-1,14	-1,20	-1,80	-1,77	-1,60	-1,39	-1,34	-1,64	-1,50	0,11
14	-2,13	-1,01	-1,15	-1,17	-1,76	-1,73	-1,58	-1,36	-1,33	-1,63	-1,48	0,11
15	-2,29	-1,14	-1,30	-1,31	-1,90	-1,86	-1,72	-1,48	-1,51	-1,79	-1,63	0,11
16	-2,24	-1,06	-1,25	-1,24	-1,79	-1,77	-1,65	-1,40	-1,41	-1,72	-1,55	0,11
17	-2,29	-1,06	-1,26	-1,23	-1,77	-1,76	-1,62	-1,39	-1,39	-1,69	-1,55	0,11
18	-2,24	-1,02	-1,19	-1,16	-1,73	-1,68	-1,55	-1,38	-1,32	-1,64	-1,49	0,11
19	-2,35	-1,15	-1,35	-1,32	-1,85	-1,74	-1,70	-1,47	-1,43	-1,76	-1,61	0,11
20	-2,37	-1,44	-1,68	-1,57	-2,09	-1,97	-1,96	-1,74	-1,70	-2,03	-1,86	0,09
21	-2,56	-1,63	-1,90	-1,73	-2,27	-2,12	-2,16	-1,92	-1,86	-2,22	-2,04	0,09

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
22	-2,68	-1,80	-1,85	-1,89	-2,37	-2,25	-2,27	-2,04	-2,02	-2,31	-2,15	0,09
23	-2,71	-1,92	-1,99	-1,97	-2,42	-2,30	-2,34	-2,14	-2,13	-2,37	-2,23	0,08
24	-2,69	-2,00	-2,06	-2,16	-2,44	-2,31	-2,41	-2,12	-2,18	-2,40	-2,28	0,07
25	-2,64	-2,07	-2,12	-2,18	-2,40	-2,30	-2,44	-2,13	-2,19	-2,38	-2,28	0,06
26	-2,55	-2,06	-2,10	-2,15	-2,33	-2,25	-2,43	-2,09	-2,15	-2,31	-2,24	0,05
27	-2,22	-1,85	-1,87	-1,90	-2,02	-1,97	-2,22	-1,85	-1,90	-2,05	-1,99	0,04
28	-1,76	-1,52	-1,53	-1,47	-1,60	-1,57	-1,86	-1,51	-1,51	-1,62	-1,59	0,04
29	-1,06	-0,82	-0,93	-0,90	-0,92	-0,91	-1,26	-0,91	-0,90	-0,95	-0,95	0,04
30	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h_{max}	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-
h_{min}	-6,10	-5,49	-5,36	-5,66	-5,95	-5,97	-5,83	-5,69	-5,69	-5,73	-5,75	-
H	6,10	5,49	5,36	5,66	5,95	5,97	5,83	5,69	5,69	5,73	**5,75**	0,07

7.1.2 Determination of the values of the deviation from the straight line connecting the extreme points of the UNIIM bridge profile

Table 7 - The deviation from the straight line connecting the extreme points of the UNIIM bridge profile at each point of the bridge, obtained by means of the dedicated measuring system of BelGIM

in µm

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	0,65	0,53	0,61	0,74	0,72	0,77	0,72	0,72	0,83	0,63	0,69	0,03
2	1,11	0,91	1,10	1,31	1,26	1,34	1,25	1,26	1,45	1,12	1,21	0,05
3	2,15	1,84	2,14	2,44	2,37	2,49	2,33	2,36	2,65	2,18	2,29	0,07
4	2,89	2,43	2,87	3,21	3,12	3,28	3,07	3,13	3,47	2,88	3,03	0,09
5	3,76	3,06	3,62	4,04	3,94	4,12	3,87	3,96	4,36	3,65	3,84	0,11
6	5,06	4,32	4,99	5,47	5,36	5,57	5,28	5,39	5,82	5,00	5,22	0,12
7	6,67	5,72	6,55	7,10	6,98	7,19	6,87	7,00	7,48	6,51	6,81	0,14
8	8,44	7,32	8,28	8,92	8,75	9,00	8,66	8,78	9,28	8,21	8,56	0,16
9	10,23	8,95	10,02	10,73	10,55	10,79	10,44	10,58	11,10	9,91	10,33	0,18
10	11,56	10,10	11,23	12,06	11,83	12,10	11,75	11,91	12,40	11,10	11,60	0,20
11	12,89	11,20	12,45	13,08	13,11	13,40	13,03	13,22	13,62	12,25	12,82	0,21
12	14,18	12,29	13,61	14,32	14,33	14,66	14,28	14,46	14,89	13,36	14,04	0,23
13	15,39	13,34	14,73	15,55	15,52	15,87	15,48	15,70	16,09	14,43	15,21	0,25
14	16,59	14,30	15,80	16,69	16,64	17,02	16,58	16,82	17,21	15,41	16,31	0,27
15	17,85	15,38	16,94	17,92	17,83	18,24	17,78	18,04	18,40	16,48	17,49	0,28
16	19,01	16,33	18,01	19,03	18,92	19,33	18,87	19,16	19,45	17,47	18,56	0,30
17	19,79	16,92	18,71	19,80	19,66	20,11	19,62	19,95	20,13	18,10	19,28	0,31
18	20,16	17,10	18,97	20,10	19,99	20,44	19,94	20,28	20,37	18,32	19,57	0,33
19	20,57	17,45	19,33	20,49	20,37	20,82	20,34	20,71	20,70	18,61	19,94	0,34
20	20,67	17,40	19,37	20,54	20,39	20,84	20,37	20,78	20,69	18,56	19,96	0,35
21	20,37	17,01	19,04	20,20	20,07	20,52	20,03	20,48	20,39	18,17	19,63	0,36
22	20,36	16,92	19,01	20,18	20,03	20,49	19,98	20,45	20,33	18,09	19,58	0,36
23	19,85	16,40	18,54	19,70	19,56	19,99	19,52	19,98	19,88	17,59	19,10	0,37
24	19,45	16,02	18,17	19,33	19,19	19,62	19,13	19,60	19,51	17,20	18,72	0,37
25	18,93	15,52	17,69	18,83	18,69	19,12	18,60	19,09	19,03	16,70	18,22	0,37
26	18,55	15,18	17,39	18,47	18,33	18,74	18,25	18,73	18,73	16,35	17,87	0,36
27	18,25	14,98	17,18	18,21	18,09	18,50	17,99	18,48	18,54	16,16	17,64	0,36
28	18,21	15,03	17,23	18,24	18,09	18,53	18,01	18,51	18,60	16,24	17,67	0,35
29	17,97	14,95	17,15	18,10	17,95	18,38	17,88	18,37	18,50	16,17	17,54	0,34
30	17,80	14,89	17,08	17,96	17,83	18,23	17,79	18,27	18,43	16,12	17,44	0,34

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
31	17,62	14,85	17,01	17,81	17,71	18,07	17,67	18,14	18,31	16,06	17,32	0,33
32	17,27	14,62	16,76	17,47	17,43	17,74	17,39	17,85	18,06	15,84	17,04	0,32
33	16,57	14,09	16,21	16,85	16,83	17,08	16,75	17,23	17,43	15,32	16,43	0,30
34	15,48	13,11	15,25	15,81	15,79	16,03	15,70	16,15	16,38	14,39	15,41	0,29
35	14,24	11,97	14,10	14,58	14,60	14,80	14,49	14,92	15,19	13,46	14,24	0,28
36	12,41	10,24	12,33	12,79	12,79	12,98	12,68	13,10	13,39	11,78	12,45	0,27
37	10,58	8,54	10,55	10,96	10,95	11,12	10,86	11,27	11,56	10,08	10,65	0,25
38	8,61	6,66	8,63	9,01	8,97	9,16	8,92	9,27	9,61	8,24	8,71	0,24
39	7,09	6,09	7,17	7,49	7,48	7,62	7,38	7,74	8,09	6,87	7,30	0,16
40	5,51	4,47	5,60	5,90	5,91	6,01	5,81	6,10	6,47	5,41	5,72	0,16
41	4,33	3,47	4,43	4,64	4,70	4,80	4,59	4,86	5,21	4,31	4,53	0,14
42	3,51	2,69	3,61	3,79	3,88	3,95	3,74	3,99	4,36	3,61	3,71	0,13
43	3,07	2,29	3,16	3,25	3,40	3,45	3,24	3,44	3,86	3,26	3,24	0,12
44	2,59	1,91	2,72	2,75	2,93	2,86	2,75	2,93	3,29	2,91	2,76	0,11
45	1,71	1,07	1,86	1,85	2,01	1,95	1,85	1,98	2,33	2,09	1,87	0,10
46	0,94	0,65	1,09	1,12	1,23	1,19	1,11	1,19	1,47	1,43	1,14	0,07
47	0,15	-0,11	0,27	0,35	0,36	0,37	0,28	0,39	0,56	-0,27	0,23	0,07
48	-0,34	-0,45	-0,23	-0,15	-0,16	-0,16	-0,20	-0,13	-0,04	-0,61	-0,25	0,05
49	-0,26	-0,32	-0,21	-0,17	-0,19	-0,20	-0,21	-0,16	-0,09	-0,41	-0,22	0,03
50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h_{max}	20,67	17,45	19,37	20,54	20,39	20,84	20,37	20,78	20,70	18,61	19,96	-
h_{min}	-0,34	-0,45	-0,23	-0,17	-0,19	-0,20	-0,21	-0,16	-0,09	-0,61	-0,25	-
H	21,01	17,90	19,60	20,72	20,58	21,04	20,58	20,95	20,80	19,23	**20,21**	0,31

Table 8 - The deviation from the straight line connecting the extreme points of the UNIIM bridge profile at each point of the bridge, obtained by means of the dedicated measuring system of UNIIM

in µm

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	0,63	0,10	0,74	0,73	0,26	0,55	0,47	0,08	0,63	0,48	0,47	0,07
2	1,01	0,51	1,21	1,23	0,91	1,08	1,14	0,72	1,20	0,94	0,99	0,07
3	1,97	1,48	2,30	2,32	2,01	2,15	2,32	1,75	2,31	2,06	2,07	0,08
4	2,68	2,18	3,20	3,06	2,83	2,95	3,09	2,54	3,11	2,95	2,86	0,09
5	3,20	2,72	3,90	3,67	3,45	3,63	3,83	3,00	3,55	3,62	3,46	0,11
6	4,25	3,91	5,12	4,90	4,75	4,93	5,14	4,37	4,83	5,01	4,72	0,12
7	5,69	5,32	6,67	6,46	6,29	6,47	6,65	5,88	6,30	6,55	6,23	0,14
8	7,37	7,04	8,49	8,28	8,14	8,33	8,55	7,69	8,08	8,40	8,04	0,15
9	9,01	8,69	10,09	9,98	9,86	10,14	10,32	9,38	9,71	10,19	9,74	0,16
10	10,25	9,97	11,37	11,28	11,11	11,53	11,70	10,62	10,93	11,54	11,03	0,18
11	11,41	11,10	12,59	12,51	12,15	12,83	13,02	11,85	12,03	12,78	12,23	0,19
12	12,60	12,32	13,82	13,75	13,42	14,19	14,34	13,06	13,24	14,03	13,48	0,20
13	13,72	13,48	15,00	14,99	14,55	15,41	15,58	14,22	14,34	15,06	14,64	0,21
14	14,94	14,58	16,11	16,14	15,61	16,56	16,65	15,38	15,38	16,03	15,74	0,20
15	16,03	15,64	17,12	17,27	16,49	17,74	17,64	16,48	16,37	17,15	16,79	0,21
16	17,01	16,61	18,07	18,28	17,37	18,81	18,57	17,42	17,23	18,14	17,75	0,22
17	17,71	17,30	18,72	18,95	17,94	19,50	19,22	18,08	17,83	18,83	18,41	0,22
18	18,08	17,61	19,03	19,28	18,24	19,70	19,55	18,39	18,14	19,18	18,72	0,21
19	18,58	17,98	19,41	19,70	18,55	20,08	19,91	18,72	18,51	19,44	19,09	0,21
20	18,68	18,04	19,50	19,73	18,60	20,15	20,08	18,74	18,63	19,41	19,16	0,21
21	18,43	17,78	19,25	19,43	18,20	19,93	19,88	18,43	18,41	19,17	18,89	0,22
22	18,35	17,66	18,92	19,27	17,95	19,81	19,73	18,22	18,34	19,08	18,73	0,22
23	17,89	17,24	18,50	18,81	17,34	19,42	19,35	17,79	18,01	18,59	18,29	0,23
24	17,57	16,90	18,11	18,32	16,82	19,03	18,98	17,49	17,62	18,20	17,90	0,23

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
25	17,20	16,46	17,68	17,86	16,25	18,57	18,55	16,91	17,16	17,70	17,43	0,24
26	16,83	16,09	17,32	17,40	15,72	18,20	18,21	16,53	16,88	17,33	17,05	0,24
27	16,52	15,93	17,15	17,17	15,43	18,02	18,05	15,78	16,43	17,14	16,76	0,27
28	16,60	16,00	17,20	17,12	15,39	18,05	18,04	15,87	16,42	17,23	16,79	0,27
29	16,58	16,04	17,24	17,15	15,19	17,96	18,03	15,93	16,38	17,22	16,77	0,27
30	16,55	15,95	17,19	17,11	15,00	17,88	17,98	15,86	16,28	17,19	16,70	0,28
31	16,51	15,86	17,13	17,03	14,93	17,73	17,90	15,67	16,18	17,11	16,60	0,28
32	16,24	15,59	16,77	16,70	14,68	17,35	17,58	15,38	15,82	16,71	16,28	0,27
33	15,89	15,16	16,31	16,26	14,30	16,84	16,96	14,99	15,45	16,18	15,83	0,25
34	14,98	14,15	15,27	15,23	13,36	15,83	15,94	13,22	14,46	15,12	14,76	0,28
35	13,88	13,00	14,05	14,04	12,21	14,41	14,60	12,04	13,24	13,87	13,53	0,26
36	11,84	11,33	12,30	12,35	10,61	12,63	12,89	10,42	11,54	12,20	11,81	0,25
37	9,98	9,63	10,51	10,59	9,01	10,81	11,09	8,89	9,88	10,51	10,09	0,22
38	8,03	7,78	8,64	8,71	7,27	8,96	9,25	7,15	8,01	8,68	8,25	0,21
39	6,26	6,17	7,02	7,07	5,66	7,23	7,53	5,67	6,42	7,03	6,60	0,20
40	4,54	4,62	5,42	5,47	4,17	5,60	5,85	4,23	4,90	5,44	5,02	0,18
41	3,14	3,47	4,21	4,26	3,10	4,35	4,59	3,20	3,75	4,18	3,83	0,17
42	2,41	2,80	3,54	3,57	2,49	3,53	3,89	2,60	3,14	3,41	3,14	0,16
43	1,96	2,29	3,03	3,06	2,07	2,96	3,18	2,19	2,63	2,90	2,63	0,14
44	1,74	2,06	2,72	2,71	1,86	2,70	2,79	2,09	2,43	2,61	2,37	0,12
45	0,95	1,23	1,77	1,77	1,09	1,78	1,94	1,31	1,63	1,77	1,52	0,10
46	0,33	0,54	0,98	0,97	0,43	0,98	1,10	0,62	0,87	0,95	0,78	0,08
47	-0,26	-0,15	0,23	0,24	-0,14	0,20	0,35	0,00	0,20	0,24	0,09	0,06
48	-0,58	-0,51	-0,25	-0,24	-0,51	-0,29	-0,20	-0,40	-0,28	-0,30	-0,36	0,04
49	-0,44	-0,39	-0,27	-0,25	-0,40	-0,27	-0,28	-0,27	-0,25	-0,26	-0,31	0,02
50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h_{max}	18,68	18,04	19,50	19,73	18,60	20,15	20,08	18,74	18,63	19,44	19,16	-
h_{min}	-0,58	-0,51	-0,27	-0,25	-0,51	-0,29	-0,28	-0,40	-0,28	-0,30	-0,36	-
H	19,26	18,55	19,76	19,99	19,11	20,44	20,36	19,14	18,91	19,74	**19,51**	0,19

Table 9 - The deviation from the straight line connecting the extreme points of the UNIIM bridge profile at each point of the bridge, obtained by means of the dedicated measuring system of SKS RSE KazInMetr

in μm

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	0,64	0,56	0,64	0,74	0,63	0,63	0,74	0,61	0,47	0,56	0,62	0,02
2	1,08	1,00	1,12	1,33	1,16	1,14	1,30	1,07	0,82	0,96	1,10	0,05
3	1,98	1,90	2,10	2,40	2,18	2,15	2,44	2,12	1,71	1,93	2,09	0,07
4	2,57	2,53	2,75	3,14	2,85	2,85	3,25	2,83	2,31	2,53	2,76	0,09
5	3,29	3,21	3,45	3,93	3,60	3,60	4,08	3,59	2,94	3,21	3,49	0,10
6	4,49	4,43	4,73	5,28	4,91	4,92	5,51	4,94	4,17	4,49	4,79	0,12
7	5,96	5,92	6,27	6,88	6,45	6,46	7,15	6,49	5,58	5,96	6,31	0,14
8	7,57	7,54	7,95	8,64	8,14	8,17	8,92	8,19	7,17	7,62	7,99	0,16
9	9,28	9,28	9,69	10,46	9,91	9,94	10,72	9,91	8,78	9,32	9,73	0,18
10	10,47	10,51	10,94	11,75	11,21	11,22	12,01	11,13	9,93	10,54	10,97	0,19
11	11,64	11,68	12,16	13,26	12,42	12,44	13,27	12,31	11,09	11,71	12,20	0,21
12	12,75	12,83	13,35	14,51	13,61	13,64	14,50	13,47	12,15	12,86	13,37	0,23
13	13,87	13,96	14,52	15,67	14,80	14,81	15,79	14,70	13,23	14,00	14,54	0,24
14	14,94	15,05	15,67	16,90	15,95	16,43	16,91	15,74	14,22	15,07	15,69	0,27
15	16,05	16,19	16,86	18,09	17,10	17,62	18,12	16,90	15,37	16,19	16,85	0,27

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
16	17,12	17,29	18,00	19,26	18,23	18,73	19,23	17,96	16,39	17,23	17,94	0,28
17	17,77	17,96	18,71	20,01	18,92	19,43	19,95	18,59	17,06	17,92	18,63	0,29
18	17,94	18,18	19,00	20,34	19,19	19,74	20,21	18,83	17,31	18,14	18,89	0,30
19	18,26	18,55	19,42	20,79	19,59	20,14	20,61	19,14	17,66	18,49	19,26	0,31
20	18,20	18,53	19,43	20,83	19,59	20,15	20,61	19,28	17,61	18,50	19,27	0,32
21	17,81	18,16	19,10	20,57	19,23	19,79	20,21	18,91	17,25	18,17	18,92	0,32
22	17,74	18,10	19,12	20,55	19,14	19,69	20,11	18,77	17,12	18,07	18,84	0,33
23	17,24	17,60	18,60	20,06	18,61	19,16	19,60	18,20	16,59	17,54	18,32	0,33
24	16,84	17,19	18,18	19,66	18,16	18,74	19,15	17,74	16,16	17,12	17,89	0,33
25	16,37	16,73	17,66	19,17	17,64	18,21	18,62	17,27	15,58	16,57	17,38	0,33
26	16,05	16,40	17,29	18,82	17,26	17,82	18,26	16,86	15,22	16,21	17,02	0,33
27	15,81	16,22	17,05	18,54	17,03	17,56	17,99	16,59	14,99	15,98	16,77	0,32
28	15,86	16,30	17,05	18,56	17,06	17,57	18,00	16,62	15,05	16,03	16,81	0,32
29	15,70	16,17	16,88	18,39	16,89	17,39	17,83	16,48	14,93	15,92	16,66	0,31
30	15,58	16,08	16,75	18,23	16,78	17,23	17,67	16,32	14,81	15,80	16,52	0,31
31	15,47	15,99	16,61	18,08	16,67	17,08	17,53	16,18	14,68	15,70	16,40	0,30
32	15,24	15,75	16,34	17,81	16,41	16,78	17,22	15,91	14,44	15,46	16,14	0,30
33	14,66	15,10	15,66	17,13	15,75	16,14	16,60	15,29	13,84	14,87	15,50	0,29
34	13,67	14,11	14,67	16,10	14,75	15,12	15,63	14,31	13,66	13,93	14,59	0,25
35	12,53	12,99	13,52	14,93	13,61	13,94	14,45	13,15	12,52	12,80	13,44	0,24
36	10,79	11,23	11,75	13,14	11,86	12,15	12,66	11,42	10,80	11,12	11,69	0,23
37	9,04	9,51	10,09	11,28	10,11	10,37	10,87	9,66	9,10	9,41	9,94	0,22
38	7,16	7,61	8,14	9,31	8,18	8,42	8,88	7,77	7,25	7,54	8,03	0,21
39	5,78	6,18	6,66	7,77	6,70	6,92	7,37	6,32	5,82	6,10	6,56	0,20
40	4,34	4,72	5,16	6,22	5,19	5,36	5,79	4,85	4,38	4,65	5,06	0,18
41	3,16	3,53	3,93	4,93	3,96	4,15	4,54	3,68	3,26	3,51	3,87	0,17
42	2,43	2,77	3,13	4,05	3,16	3,43	3,70	2,94	2,55	2,79	3,10	0,15
43	2,12	2,40	2,74	3,56	2,74	2,96	3,21	2,53	2,19	2,40	2,68	0,14
44	1,70	1,93	2,26	3,00	2,31	2,47	2,70	2,12	1,82	2,00	2,23	0,12
45	0,98	1,16	1,46	2,09	1,50	1,63	1,81	1,35	1,08	1,26	1,43	0,10
46	0,38	0,55	0,78	1,28	0,82	0,91	1,08	0,71	0,47	0,62	0,76	0,08
47	-0,30	-0,18	0,02	0,40	0,05	0,18	0,23	-0,02	-0,22	-0,08	0,01	0,06
48	-0,59	-0,52	-0,36	-0,12	-0,36	-0,28	-0,24	-0,42	-0,53	-0,45	-0,39	0,04
49	-0,32	-0,27	-0,23	-0,09	-0,22	-0,20	-0,21	-0,29	-0,35	-0,32	-0,25	0,02
50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h_{max}	18,26	18,55	19,43	20,83	19,59	20,15	20,61	19,28	17,66	18,50	19,27	-
h_{min}	-0,59	-0,52	-0,36	-0,12	-0,36	-0,28	-0,24	-0,42	-0,53	-0,45	-0,39	-
H	18,85	19,07	19,80	20,95	19,94	20,44	20,85	19,70	18,19	18,95	**19,66**	0,27

7.1.3 Determination of the values of the deviation from the straight line connecting the extreme points of the SKS RSE KazInMetr bridge profile

Table 10 - The deviation from the straight line connecting the extreme points of the SKS RSE KazInMetr bridge profile at each point of the bridge, obtained by means of the dedicated measuring system of BelGIM

in μm

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	-0,04	0,00	0,10	0,22	0,21	-0,08	0,02	0,18	0,29	-0,03	0,09	0,04
2	-0,26	-0,19	0,03	0,27	0,19	-0,34	-0,11	0,13	0,31	-0,28	-0,03	0,08
3	0,87	0,98	1,30	1,68	1,58	0,72	1,06	1,45	1,75	0,89	1,23	0,12
4	0,91	0,96	1,44	1,94	1,81	0,72	1,12	1,64	2,01	0,85	1,34	0,15
5	1,13	1,19	1,80	2,41	2,21	0,90	1,40	2,04	2,50	1,00	1,66	0,19
6	1,11	1,18	1,86	2,62	2,36	0,88	1,40	2,20	2,68	0,88	1,72	0,23
7	1,03	1,10	1,89	2,73	2,44	0,79	1,36	2,29	2,81	0,74	1,72	0,26
8	0,82	0,88	1,75	2,70	2,38	0,56	1,21	2,22	2,80	0,46	1,58	0,29
9	0,45	0,52	1,44	2,50	2,13	0,19	0,90	1,98	2,61	0,03	1,28	0,31
10	0,00	0,08	1,08	2,22	1,83	-0,26	0,55	1,71	2,34	-0,46	0,91	0,34
11	-0,16	-0,05	1,03	2,20	1,81	-0,41	0,49	1,72	2,37	-0,61	0,84	0,36
12	-0,39	-0,26	0,91	2,10	1,68	-0,61	0,31	1,63	2,23	-0,91	0,67	0,38
13	-0,52	-0,35	0,86	2,12	1,71	-0,72	0,26	1,61	2,23	-1,08	0,61	0,40
14	-0,63	-0,41	0,81	2,13	1,72	-0,78	0,24	1,56	2,17	-1,23	0,56	0,41
15	-0,40	-0,23	1,12	2,44	1,99	-0,56	0,54	1,84	2,44	-1,05	0,81	0,42
16	0,00	0,16	1,54	2,87	2,45	-0,14	1,00	2,30	2,84	-0,69	1,23	0,43
17	0,32	0,49	1,92	3,22	2,85	0,31	1,36	2,64	3,20	-0,38	1,59	0,43
18	0,68	0,86	2,30	3,60	3,21	0,64	1,72	3,03	3,52	-0,05	1,95	0,43
19	0,88	1,04	2,44	3,77	3,33	0,74	1,93	3,17	3,62	0,10	2,10	0,43
20	0,79	0,95	2,36	3,70	3,20	0,63	1,86	3,01	3,55	0,01	2,01	0,43
21	1,01	1,15	2,49	3,87	3,31	0,79	2,03	3,12	3,68	0,13	2,16	0,42
22	1,38	1,51	2,79	4,20	3,59	1,11	2,38	3,43	3,96	0,46	2,48	0,41
23	1,74	1,82	3,14	4,52	3,87	1,42	2,71	3,69	4,24	0,77	2,79	0,41
24	1,97	2,01	3,26	4,65	3,98	1,57	2,91	3,81	4,36	0,94	2,94	0,40
25	2,21	2,17	3,35	4,70	4,05	1,69	3,06	3,90	4,43	1,09	3,07	0,39
26	1,97	1,94	3,05	4,36	3,73	1,42	2,80	3,58	4,09	0,86	2,78	0,38
27	1,29	1,24	2,32	3,58	2,97	0,71	2,11	2,82	3,30	0,19	2,05	0,36
28	0,44	0,39	1,45	2,67	2,06	-0,13	1,23	1,91	2,36	-0,66	1,17	0,35
29	-0,51	-0,58	0,43	1,62	1,03	-1,09	0,26	0,87	1,25	-1,61	0,17	0,34
30	-1,44	-1,54	-0,58	0,59	0,01	-2,02	-0,75	-0,17	0,19	-2,54	-0,82	0,32
31	-2,52	-2,60	-1,73	-0,59	-1,16	-3,06	-1,84	-1,36	-1,00	-3,55	-1,94	0,30
32	-3,33	-3,44	-2,61	-1,56	-2,13	-3,87	-2,74	-2,29	-1,96	-4,26	-2,82	0,28
33	-3,69	-3,85	-3,11	-2,17	-2,66	-4,26	-3,18	-2,81	-2,50	-4,59	-3,28	0,25
34	-3,41	-3,55	-2,90	-2,07	-2,51	-3,83	-2,94	-2,60	-2,39	-4,19	-3,04	0,22
35	-3,01	-3,13	-2,57	-1,89	-2,25	-3,33	-2,59	-2,33	-2,13	-3,66	-2,69	0,18
36	-2,55	-2,66	-2,17	-1,63	-1,93	-2,81	-2,08	-1,99	-1,82	-3,09	-2,27	0,15
37	-2,19	-2,24	-1,89	-1,47	-1,69	-2,31	-1,85	-1,74	-1,63	-2,61	-1,96	0,11
38	-1,62	-1,65	-1,40	-1,12	-1,25	-1,71	-1,35	-1,36	-1,17	-1,91	-1,45	0,08
39	-0,59	-0,62	-0,51	-0,39	-0,44	-0,63	-0,44	-0,46	-0,39	-0,77	-0,52	0,04
40	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h_{max}	2,21	2,17	3,35	4,70	4,05	1,69	3,06	3,90	4,43	1,09	3,07	-
h_{min}	-3,69	-3,85	-3,11	-2,17	-2,66	-4,26	-3,18	-2,81	-2,50	-4,59	-3,28	-
H	5,91	6,02	6,46	6,87	6,71	5,95	6,24	6,71	6,94	5,68	**6,35**	0,14

Table 11 - The deviation from the straight line connecting the extreme points of the SKS RSE KazInMetr bridge profile at each point of the bridge, obtained by means of the dedicated measuring system of UNIIM

in µm

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	-0,18	-0,08	-0,22	-0,05	0,08	-0,21	0,00	-0,04	-0,14	0,06	-0,08	0,03
2	-0,46	-0,32	-0,56	-0,25	0,00	-0,57	-0,22	-0,19	-0,32	-0,04	-0,29	0,06
3	0,71	0,91	0,59	0,93	1,34	0,56	0,94	1,15	0,93	1,31	0,94	0,09
4	0,71	1,00	0,54	1,04	1,54	0,52	1,02	1,30	1,01	1,51	1,02	0,11
5	0,94	1,29	0,80	1,29	1,92	0,66	1,29	1,63	1,28	1,86	1,30	0,13
6	0,65	1,08	0,52	1,13	1,91	0,39	1,14	1,56	1,14	1,88	1,14	0,17
7	0,46	0,94	0,34	1,07	1,95	0,23	0,95	1,52	1,02	1,84	1,03	0,19
8	0,11	0,65	0,00	0,77	1,78	-0,17	0,62	1,32	0,81	1,63	0,75	0,21
9	-0,31	0,34	-0,38	0,44	1,55	-0,55	0,26	1,04	0,56	1,39	0,43	0,23
10	-0,81	-0,14	-0,88	-0,10	1,10	-1,06	-0,31	0,60	0,14	0,97	-0,05	0,24
11	-0,96	-0,20	-0,97	-0,23	1,10	-1,17	-0,39	0,55	0,18	1,00	-0,11	0,26
12	-1,39	-0,53	-1,34	-0,55	0,77	-1,52	-0,73	0,23	-0,07	0,75	-0,44	0,27
13	-1,61	-0,74	-1,56	-0,72	0,62	-1,73	-0,91	0,05	-0,22	0,62	-0,62	0,28
14	-1,68	-0,78	-1,64	-0,77	0,62	-1,81	-0,93	0,03	-0,22	0,60	-0,66	0,29
15	-1,53	-0,59	-1,45	-0,57	0,86	-1,67	-0,74	0,25	0,00	0,81	-0,46	0,29
16	-1,09	-0,13	-1,07	-0,12	1,37	-1,23	-0,33	0,74	0,50	1,30	-0,01	0,30
17	-0,92	0,06	-0,85	0,08	1,57	-1,05	-0,13	0,99	0,77	1,53	0,20	0,31
18	-0,60	0,40	-0,46	0,48	1,93	-0,68	0,24	1,32	1,15	1,90	0,57	0,31
19	-0,48	0,54	-0,36	0,62	2,12	-0,48	0,43	1,53	1,37	2,05	0,73	0,32
20	-0,41	0,60	-0,28	0,73	2,15	-0,42	0,47	1,56	1,56	2,14	0,81	0,32
21	-0,16	0,86	-0,05	0,96	2,34	-0,14	0,69	1,80	1,81	2,37	1,05	0,31
22	0,10	1,12	0,23	1,27	2,56	0,14	0,95	2,05	2,10	2,63	1,32	0,31
23	0,35	1,37	0,49	1,56	2,78	0,47	1,25	2,32	2,40	2,88	1,59	0,31
24	0,62	1,62	0,76	1,82	2,97	0,72	1,46	2,52	2,63	3,06	1,82	0,30
25	0,76	1,79	0,86	1,90	3,00	0,88	1,62	2,60	2,80	3,16	1,94	0,29
26	0,56	1,54	0,70	1,64	2,71	0,66	1,36	2,31	2,52	2,84	1,68	0,28
27	-0,10	0,84	0,03	0,97	1,99	0,03	0,70	1,58	1,85	2,22	1,01	0,27
28	-0,85	0,11	-0,68	0,20	1,16	-0,71	-0,08	0,76	1,00	1,41	0,23	0,26
29	-1,77	-0,86	-1,62	-0,76	0,14	-1,58	-1,04	-0,22	0,05	0,45	-0,72	0,25
30	-2,62	-1,79	-2,43	-1,70	-0,81	-2,44	-1,98	-1,17	-0,90	-0,60	-1,64	0,23
31	-3,64	-2,86	-3,51	-2,81	-1,95	-3,42	-3,05	-2,29	-2,01	-1,75	-2,73	0,22
32	-4,47	-3,77	-4,34	-3,69	-2,88	-4,25	-3,92	-3,23	-2,94	-2,73	-3,62	0,20
33	-4,77	-4,13	-4,65	-4,09	-3,35	-4,54	-4,23	-3,62	-3,31	-3,13	-3,98	0,19
34	-4,40	-3,89	-4,32	-3,83	-3,19	-4,21	-3,92	-3,42	-3,11	-2,96	-3,73	0,17
35	-3,89	-3,44	-3,86	-3,30	-2,89	-3,69	-3,37	-2,95	-2,72	-2,57	-3,27	0,15
36	-3,33	-2,96	-3,32	-2,89	-2,53	-3,26	-3,01	-2,66	-2,41	-2,24	-2,86	0,12
37	-2,86	-2,48	-2,77	-2,45	-2,12	-2,74	-2,51	-2,25	-2,00	-1,87	-2,41	0,11
38	-2,18	-1,91	-2,08	-1,86	-1,65	-2,03	-1,91	-1,68	-1,56	-1,50	-1,83	0,07
39	-0,77	-0,65	-0,71	-0,62	-0,50	-0,70	-0,64	-0,53	-0,45	-0,42	-0,60	0,04
40	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h_{max}	0,94	1,79	0,86	1,90	3,00	0,88	1,62	2,60	2,80	3,16	1,95	-
h_{min}	-4,77	-4,13	-4,65	-4,09	-3,35	-4,54	-4,23	-3,62	-3,31	-3,13	-3,98	-
H	5,71	5,92	5,51	5,99	6,35	5,42	5,84	6,22	6,10	6,29	**5,93**	0,10

Table 12 - The deviation from the straight line connecting the extreme points of the SKS RSE KazInMetr bridge profile at each point of the bridge, obtained by means of the dedicated measuring system of SKS RSE KazInMetr

in µm

Point number	Deviation from the line connecting the extreme profile point for the measurement series No.										Arithmetic mean of measurement results	Type A standard uncertainty
	1	2	3	4	5	6	7	8	9	10		
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1	-0,16	0,10	0,15	-0,12	0,17	0,07	0,19	0,26	0,33	0,00	0,10	0,05
2	-0,51	0,07	0,15	-0,36	0,14	-0,01	0,22	0,37	0,37	-0,31	0,01	0,10
3	0,49	1,32	1,49	0,71	1,40	1,22	1,57	1,81	1,77	0,90	1,27	0,14
4	0,38	1,64	1,71	0,58	1,51	1,27	1,79	2,06	2,01	0,90	1,39	0,19
5	0,47	1,95	2,11	0,72	1,81	1,54	2,17	2,46	2,45	1,23	1,69	0,22
6	0,37	2,00	2,21	0,58	1,84	1,57	2,26	2,63	2,59	1,36	1,74	0,25
7	0,23	2,01	2,24	0,40	1,80	1,51	2,33	2,73	2,69	1,27	1,72	0,28
8	-0,07	1,87	2,16	0,08	1,58	1,33	2,23	2,65	2,62	1,10	1,56	0,30
9	-0,55	1,55	1,89	-0,21	1,18	0,99	1,99	2,45	2,38	0,74	1,24	0,32
10	-1,11	1,16	1,54	-0,70	0,74	0,58	1,69	2,20	2,06	0,30	0,85	0,35
11	-1,46	0,79	1,49	-0,94	0,57	0,45	1,67	2,24	2,02	0,08	0,69	0,39
12	-1,74	0,65	1,33	-1,27	0,29	0,22	1,55	2,10	1,86	-0,11	0,49	0,41
13	-1,91	0,48	1,26	-1,50	0,08	0,08	1,49	2,04	1,88	-0,31	0,36	0,43
14	-2,09	0,41	1,18	-1,92	-0,02	0,00	1,48	1,97	2,08	-0,46	0,26	0,47
15	-1,94	0,63	1,41	-1,79	0,14	0,10	1,80	2,21	2,37	-0,25	0,47	0,48
16	-1,59	0,93	1,81	-1,44	0,50	0,51	2,25	2,57	2,84	0,12	0,85	0,49
17	-1,36	1,25	2,12	-1,17	0,79	0,88	2,67	2,98	3,19	0,45	1,18	0,51
18	-1,03	1,60	2,43	-0,80	1,29	1,29	3,25	3,29	3,58	0,82	1,57	0,51
19	-0,99	1,77	2,59	-0,66	1,40	1,46	3,44	3,40	3,76	1,02	1,72	0,52
20	-1,10	1,64	2,45	-0,79	1,28	1,37	3,36	3,39	3,67	0,98	1,63	0,53
21	-0,92	1,78	2,58	-0,64	1,41	1,55	3,52	3,53	3,82	1,06	1,77	0,52
22	-0,77	2,04	2,84	-0,31	1,77	1,89	3,73	3,85	4,08	1,39	2,05	0,53
23	-0,40	2,27	3,09	0,06	2,11	2,23	4,05	4,12	4,37	1,70	2,36	0,52
24	-0,14	2,48	3,24	0,25	2,25	2,44	4,18	4,26	4,49	1,85	2,53	0,50
25	0,06	2,53	3,33	0,36	2,34	2,62	4,16	4,31	4,54	2,19	2,64	0,49
26	-0,16	2,26	3,00	0,12	2,06	2,38	3,80	3,98	4,21	1,97	2,36	0,47
27	-0,76	1,57	2,25	-0,58	1,36	1,54	3,01	3,19	3,41	1,24	1,62	0,46
28	-1,49	0,68	1,36	-1,40	0,45	0,62	2,08	2,27	2,42	0,38	0,74	0,44
29	-2,35	-0,30	0,36	-2,31	-0,50	-0,29	1,01	1,21	1,34	-0,61	-0,24	0,42
30	-3,16	-1,26	-0,64	-3,18	-1,42	-1,28	0,02	0,17	0,25	-1,59	-1,21	0,39
31	-4,09	-2,39	-1,78	-4,01	-2,45	-2,35	-1,16	-1,00	-0,99	-2,66	-2,29	0,35
32	-4,77	-3,27	-2,65	-4,71	-3,28	-3,34	-2,11	-1,89	-1,89	-3,46	-3,14	0,33
33	-5,06	-3,69	-3,15	-4,99	-3,71	-3,72	-2,66	-2,40	-2,40	-3,84	-3,56	0,30
34	-4,57	-3,42	-2,91	-4,53	-3,42	-3,42	-2,48	-2,25	-2,25	-3,50	-3,28	0,26
35	-3,99	-3,02	-2,58	-3,98	-3,03	-2,97	-2,18	-1,98	-1,99	-3,06	-2,88	0,23
36	-3,34	-2,52	-2,16	-3,33	-2,61	-2,51	-1,84	-1,66	-1,69	-2,59	-2,42	0,19
37	-2,77	-2,16	-1,86	-2,84	-2,20	-2,06	-1,62	-1,45	-1,53	-2,10	-2,06	0,15
38	-1,97	-1,59	-1,31	-2,08	-1,63	-1,51	-1,21	-1,13	-1,11	-1,73	-1,53	0,11
39	-0,73	-0,59	-0,42	-0,83	-0,67	-0,59	-0,43	-0,38	-0,37	-1,00	-0,60	0,07
40	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
h_{max}	0,49	2,53	3,33	0,72	2,34	2,62	4,18	4,31	4,54	2,19	2,64	-
h_{min}	-5,06	-3,69	-3,15	-4,99	-3,71	-3,72	-2,66	-2,40	-2,40	-3,84	-3,56	-
H	5,55	6,22	6,48	5,71	6,04	6,34	6,84	6,71	6,94	6,03	**6,29**	0,15

7.2 The graph of the BelGIM bridge profile drawn from the measurements results of each comparison participant is shown in Figure 7.

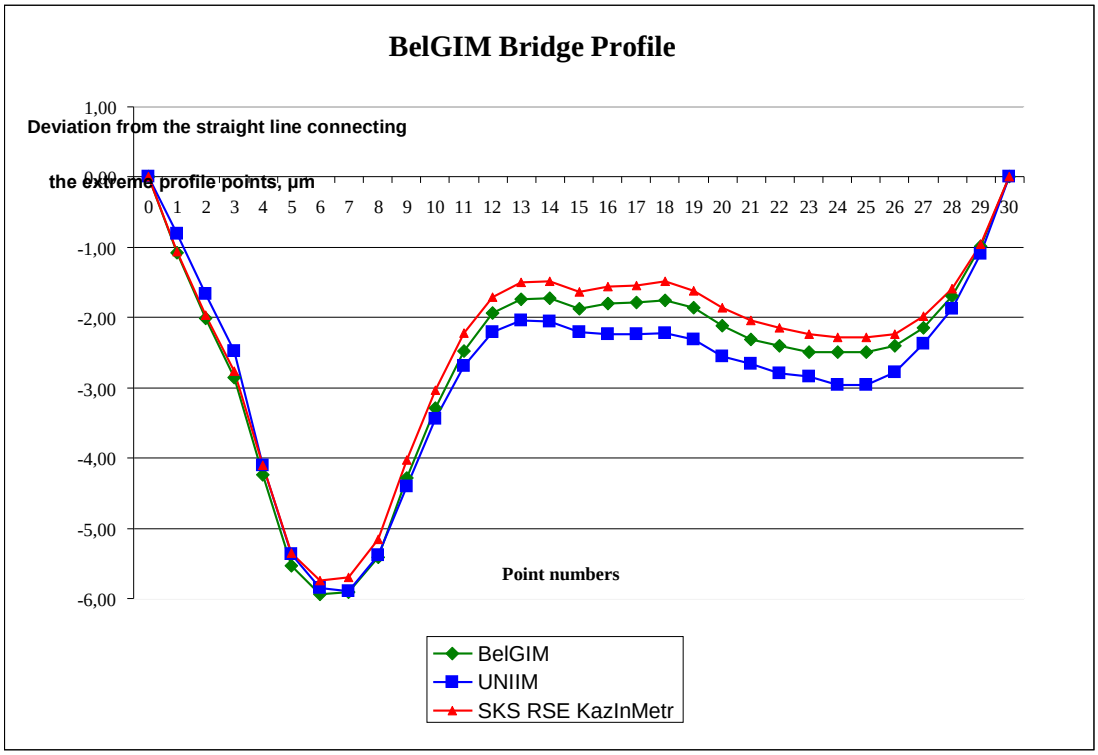

Figure 7 – The graph of the deviations from the straight line connecting extreme points of the Bel-GIM bridge

7.3 The graph of the UNIIM bridge profile drawn from the measurements results of each comparison participant is shown in Figure.

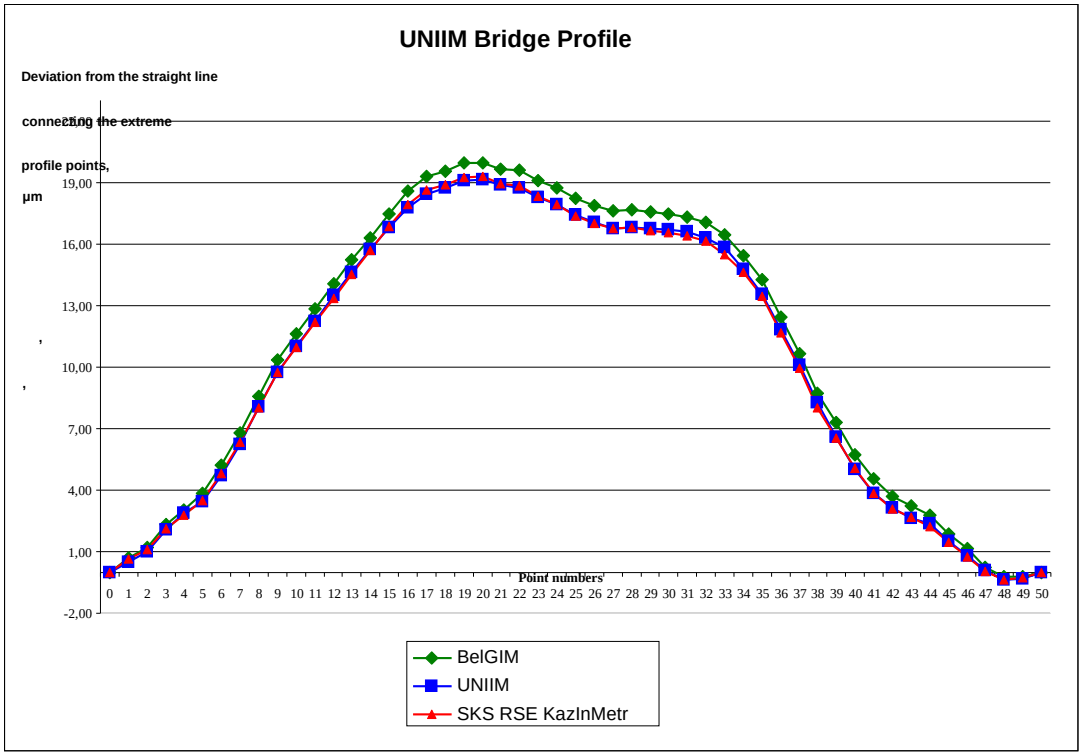

Figure 8 – The graph of the deviations from the straight line connecting extreme points of the UNIIM bridge

7.4 The graph of the SKS RSE KazInMetr bridge profile drawn from the measurements results of each comparison participant is shown in Figure 9.

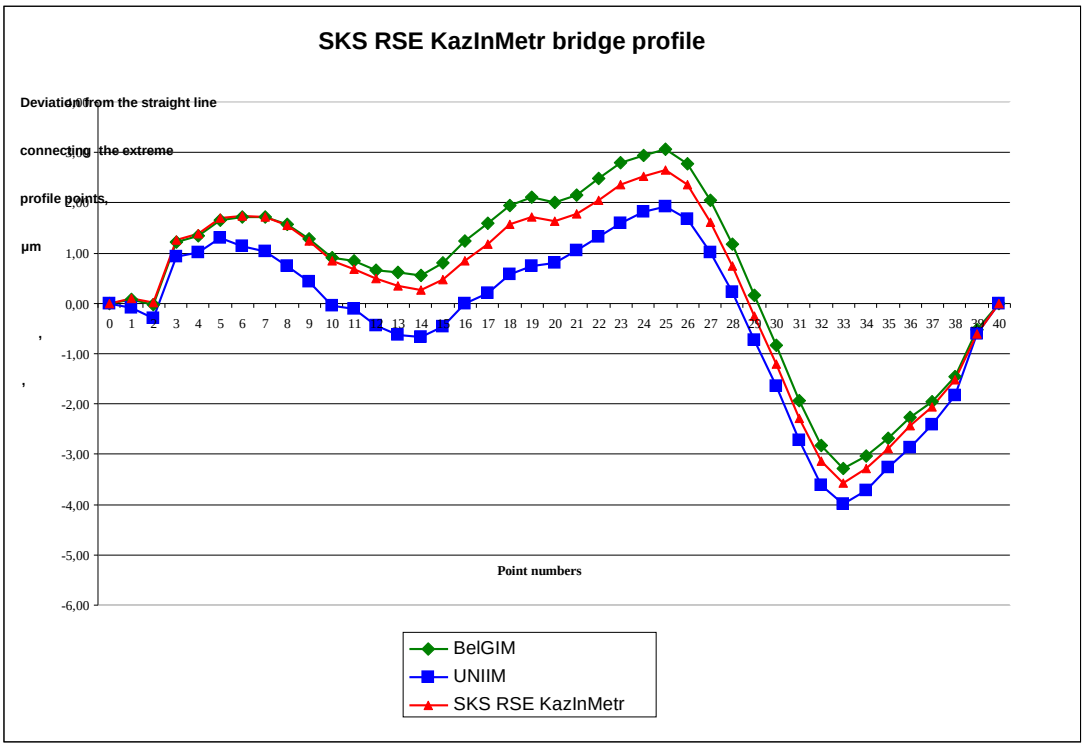

Figure 9 – The graph of the deviations from the straight line connecting extreme points of the SKS RSE KazInMetr bridge

8 Procedure of evaluating the equivalence of the national standards included in the comparisons

The results of the measurements conducted by the comparison participants were verified by using the following two methods:

- based on the *En*-criterion;
- based on the degree of equivalence of the measurement standards $(d_j, u(d_j))$

8.1 Examination of measurement results using the *En*-criterion method

To evaluate the internal closeness between the individual measurement results the *En*-criterion was applied. For k=2, $|En| \le 1$.

$$E_n = \frac{1}{k} \cdot \frac{x_j - x_{ref}}{\sqrt{u_j^2 - u_{ref}^2}} \qquad (3)$$

$$x_{ref} = \frac{\sum_{j=1}^{n} p_j \cdot x_j}{\sum_{j=1}^{n} p_j} \qquad (4)$$

$$u_{ref} = \frac{1}{\sqrt{\sum_{j=1}^{n} \frac{1}{u_j^2}}} \qquad (5)$$

$$p_j = \frac{1}{u_j^2} \qquad (6)$$

where x_j is the measurement result obtained by the j-th laboratory;

u_j is the standard uncertainty reported by the j-th laboratory;

p_j is the weight of the measurement result obtained by the j-th laboratory;

x_{ref} is the reference value (weighted average) of the comparison;

u_{ref} is the standard uncertainty of the reference value;

n is the total number of the comparison participants.

8.1.1 The values of the *En*-criterion for the BelGIM bridge are given in Table 13.

Table 13

Name of characteristic	Laboratory abbreviation		
	BelGIM	UNIIM	SKS RSE KazInMetr
Measurement result of the laboratory, x_j, μm	5,94	5,90	5,75
Total standard uncertainty reported by the laboratory, u_j, μm (k=1)	0,24 ($0{,}08L^*$)	0,30 ($0{,}10L^*$)	0,30 ($0{,}10L^*$)
Reference value (weighted average) of the comparison, x_{ref}, μm	5,88		
Standard uncertainty of the reference value, u_{ref}, μm	0,159		
En-criterion value	**0,18**	**0,05**	**-0,25**

Note: L^*, m stands for the length of the BelGIM bridge (see Table 2).

All values of the *En*-criterion for the BelGIM bridge obtained by the comparison participants are below the level specified: $|En| \le 1$.

8.1.2 The values of the En-criterion for the UNIIM bridge are given in Table 14.

Table 14

Name of characteristic	Laboratory abbreviation		
	BelGIM	UNIIM	SKS RSE KazInMetr
Measurement result of the laboratory, x_j, μm	20,21	19,51	19,66
Total standard uncertainty reported by the laboratory, u_j, μm (k=1)	0,40 ($0{,}08L^*$)	0,50 ($0{,}10L^*$)	0,50 ($0{,}10L^*$)
Reference value (weighted average) of the comparison, x_{ref}, μm	19,86		
Standard uncertainty of the reference value, u_{ref}, μm	0,265		
En-criterion value	**0,59**	**-0,41**	**-0,23**

Note: L^*, m stands for the length of the UNIIM bridge (see Table 2).

All values of the En-criterion for the UNIIM bridge obtained by the comparison participants are below the level specified: $|En| \leq 1$.

8.1.3 The values of the En-criterion for the SKS RSE KazInMetr bridge are given in Table 15.

Table 15

Name of characteristic	Laboratory abbreviation		
	BelGIM	UNIIM	SKS RSE KazInMetr
Measurement result of the laboratory, x_j, μm	6,35	5,93	6,29
Total standard uncertainty reported by the laboratory, u_j, μm (k=1)	0,32 ($0{,}08L^*$)	0,40 ($0{,}10L^*$)	0,40 ($0{,}10L^*$)
Reference value (weighted average) of the comparison, x_{ref}, μm	6,22		
Standard uncertainty of the reference value, u_{ref}, μm	0,212		
En-criterion value	**0,28**	**-0,42**	**0,11**

Note: L^*, m stands for the length of the SKS RSE KazInMetr bridge (see Table 2).

All values of the *En*-criterion for the SKS RSE KazInMetr bridge obtained by the comparison participants are below the level specified: $|En| \leq 1$.

8.2 Examination of measurement results using the degree of equivalence method $(d_j, u(d_j))$

The degree of equivalence d_j for the *j*-th institute is defined as the deviation of the measurement result from the reference value and can be calculated by formula

$$d_j = x_j - x_{ref} \quad , \tag{7}$$

where x_{ref} is the reference comparison value derived by Formula (4).

The uncertainty of the degree of equivalence, $u(d_j)$ can be calculated by formula

$$u(d_j) = \sqrt{u^2(x_j) - u^2(x_{ref})} \tag{8}$$

The minus sign shows up in Formula (6) due to correlation between the measurement result and the reference value computed with respect to that measurement result.

The measurement standards are considered to be equivalent if the following condition is fulfilled:

$$|d_j| \leq 2 \cdot u(d_j) \quad \text{or} \tag{9}$$

$$|d_j| \leq U(d_j) \tag{10}$$

8.2.1 The results of checking the degrees of equivalence for the BelGIM bridge are given in Table 16.

Table 16

Name of characteristic	Laboratory abbreviation		
	BelGIM	UNIIM	SKS RSE KazInMetr
Measurement result of the laboratory, x_j, μm	5,94	5,90	5,75
Total standard uncertainty reported by the laboratory, u_j, μm (k=1)	0,24 ($0{,}08L^*$)	0,30 ($0{,}10L^*$)	0,30 ($0{,}10L^*$)
Reference value (weighted average) of the comparison, x_{ref}, μm	5,88		
Standard uncertainty of the reference value, u_{ref}, μm	0,159		
Difference between the measured and reference value, d_j, μm	0,06	0,02	-0,13
Standard uncertainty of the degree of equivalence, $u(d_j)$, μm	0,18	0,25	0,25
Expanded uncertainty of the degree of equivalence $U(d_j)$	0,36	0,51	0,51

Note: L^*, m stands for the length of the BelGIM bridge (see Table 2).

From Table 16 it is evident, that when comparing d_j and $U(d_j)$ the condition (10) is fulfilled, therefore the measurement standards being compared are considered equivalent.

8.2.2 The results of checking the degrees of equivalence for the UNIIM bridge are given in Table 17.

Table 17

Name of characteristic	Laboratory abbreviation		
	BelGIM	UNIIM	SKS RSE KazInMetr
Measurement result of the laboratory, x_j, μm	20,21	19,51	19,66
Total standard uncertainty reported by the laboratory, u_j, μm (k=1)	0,40 ($0{,}08L^*$)	0,50 ($0{,}10L^*$)	0,50 ($0{,}10L^*$)
Reference value (weighted average) of the comparison, x_{ref}, μm	19,86		
Standard uncertainty of the reference value, u_{ref}, μm	0,265		
Difference between the measured and reference value, d_j, μm	0,35	-0,35	-0,20
Standard uncertainty of the degree of equivalence, $u(d_j)$, μm	0,30	0,42	0,42
Expanded uncertainty of the degree of equivalence $U(d_j)$	0,60	0,85	0,85

Note: L^*, m stands for the length of the UNIIM bridge (see Table 2).

From Table 17 it is evident, that when comparing dj and $U(d_j)$ the condition (10) is fulfilled, therefore the measurement standards being compared are considered equivalent.

8.2.3 The results of checking the degrees of equivalence for the SKS RSE KazInMetr bridge are given in Table 18.

Table 18

Name of characteristic	Laboratory abbreviation		
	BelGIM	UNIIM	SKS RSE KazInMetr
Measurement result of the laboratory, x_j, μm	6,35	5,93	6,29
Total standard uncertainty reported by the laboratory, u_j, μm (k=1)	0,32 ($0{,}08L^*$)	0,40 ($0{,}10L^*$)	0,40 ($0{,}10L^*$)
Reference value (weighted average) of the comparison, x_{ref}, μm	6,22		
Standard uncertainty of the reference value, u_{ref}, μm	0,212		
Difference between the measured and reference value, d_j, μm	0,13	-0,29	0,07
Standard uncertainty of the degree of equivalence, $u(d_j)$, μm	0,24	0,34	0,34
Expanded uncertainty of the degree of equivalence $U(d_j)$	0,48	0,68	0,68

Note: L^*, m stands for the length of the SKS RSE KazInMetr bridge (see Table 2).

From Table 18 it is evident, that when comparing dj and $U(d_j)$ the condition (10) is fulfilled, therefore the measurement standards being compared are considered equivalent.

8.3 The results of measurements of straightness deviations for the BelGIM bridge are shown in Figure 10.

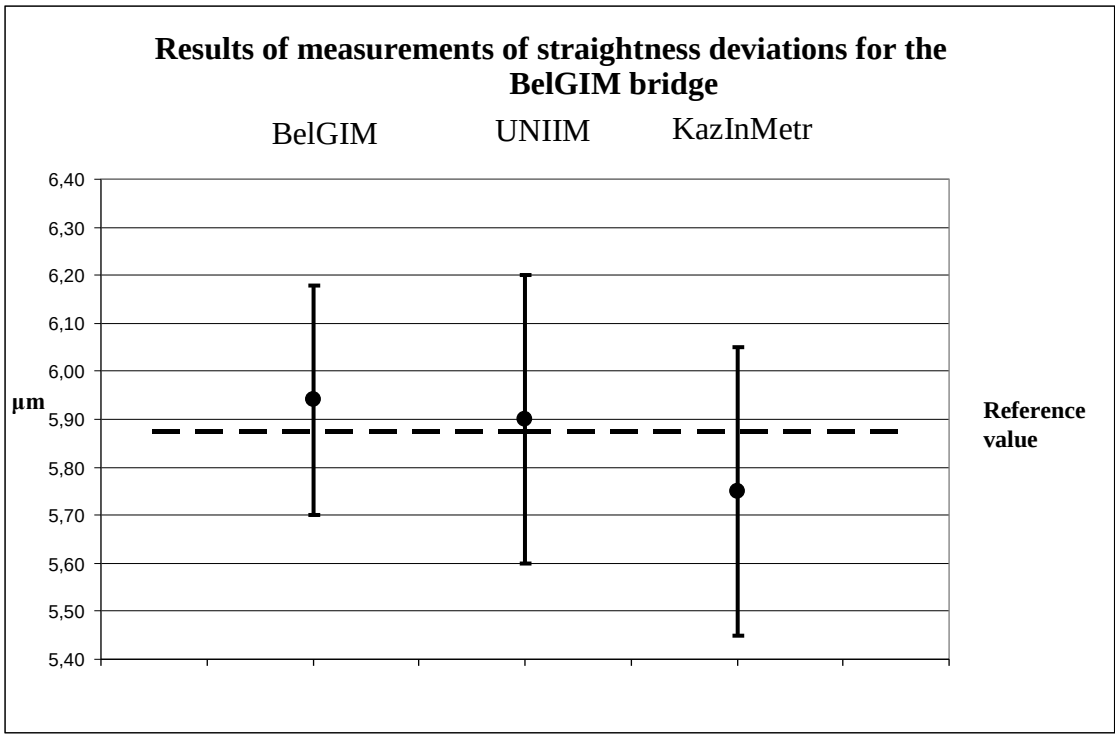

Figure 10 – Results of measurements of straightness deviations of the BelGIM bridge.

8.4 The results of measurements of straightness deviations for the UNIIM bridge are shown in Figure 11.

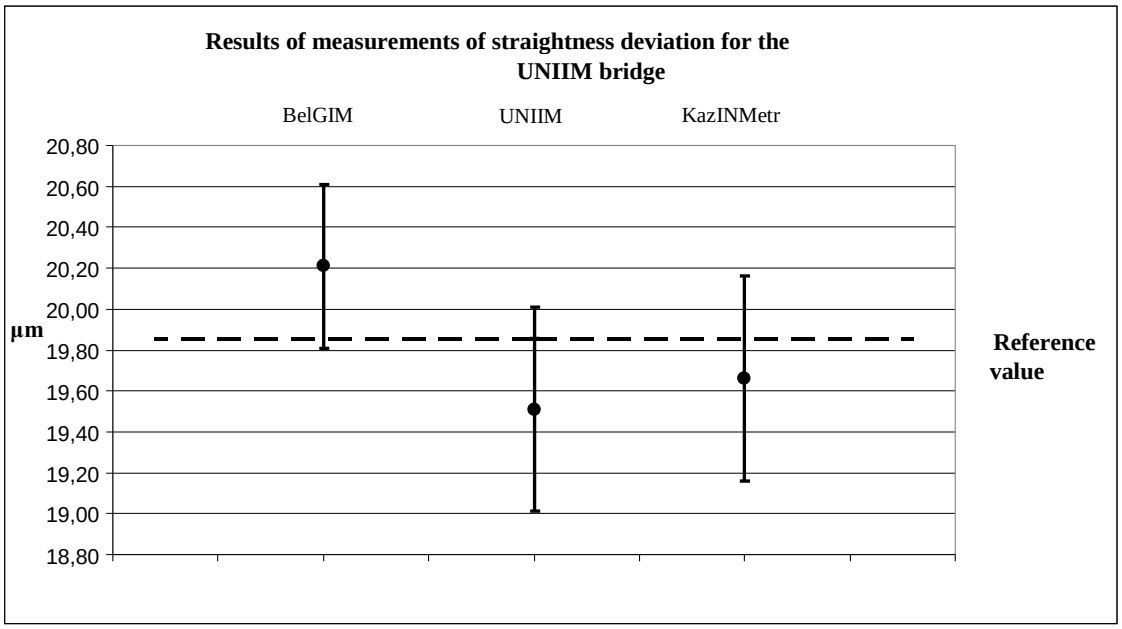

Figure 11 – Results of measurements of straightness deviations of the UNIIM bridge.

8.5 The results of measurements of straightness deviations for the SKS RSE KazInMetr bridge are shown in Figure 12.

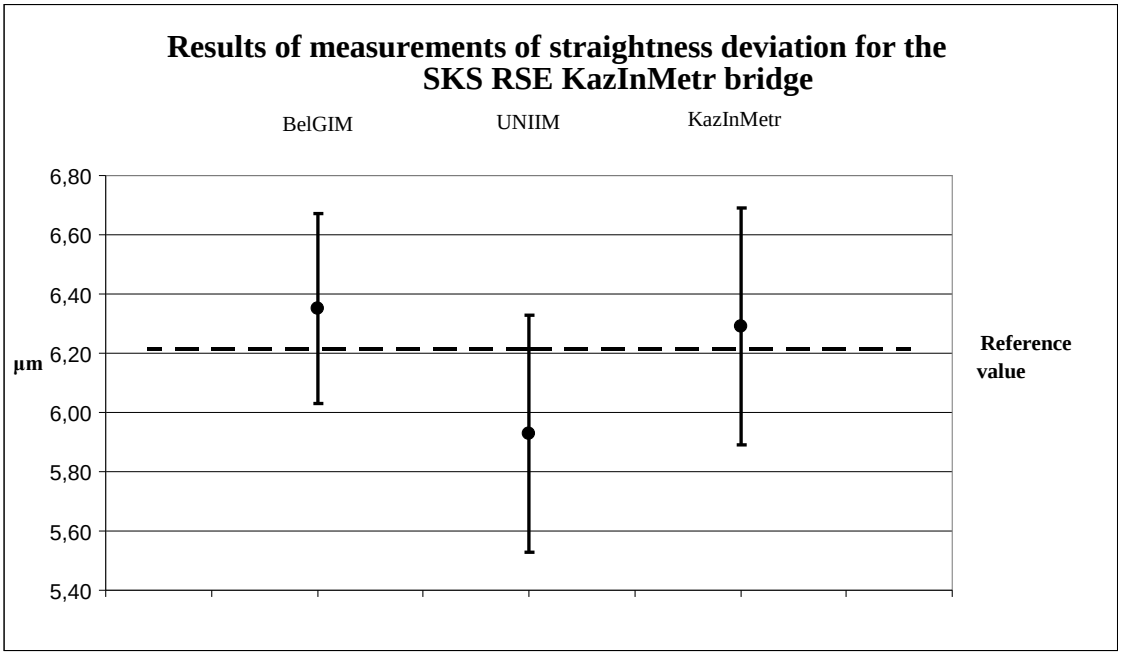

Figure 12 – Results of measurements of straightness deviations of the SKS RSE KazInMetr bridge

9 Resume

9.1 The comparison results indicate that the measurement uncertainties comply with the reported values.

9.2 The standards under comparison are equivalent.

Bibliography

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[3] COOMET R/GM/14:2016 Guidelines for Data Evaluation of COOMET Key Comparisons