

ISSS Round Robin 2012

Evaluation and interpretation of the general results

ISSS Round Robin so far

Organisation of the ISSS Round Robin 2012

Selected test methods

Selected test samples

Interpretation of the general results

Evaluation of the general results

Discussion

ISSS Round Robin 2013

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ISSS Round Robin 2013

2009 – ISSS decided to organise Round Robin on a new level

2010 – the first total independent Round Robin were conducted

– the following three test methods were compared:

Determination of :

shock absorption (EN 14808:2005)

vertical deformation (EN 14809:2005)

vertical ball behaviour (EN 12235:2004)

2011 – ISSS decided to proceed with the scheme

2012 – the second Round Robin was conducted

The interlaboratory comparison testing was conducted by:

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ISSS Round Robin 2013

- In 2011, a questionnaire was prepared and sent out to:
 - members of ISSS
 - other test institutes
 - equipment manufacturers
 - consultants
 - installers
- Ten methods were selected and split over the duration of two years
- Samples were chosen and requested by individual manufacturers
- Samples and instruction were sent out by ofi
- The testing was completed within 6 weeks
- The evaluation was returned by the middle of September 2012

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The following five test methods were compared in 2012:

Determination of

- shock absorption (EN 14808:2005)
- vertical deformation (EN 14809:2005)
- thickness (EN 1969:2000)
- slip resistance (EN 13036-4:2003)
- tensile properties (EN 12230:2003)

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ISSS Round Robin 2013

The following three different products were chosen for 2012:

- synthetic sports surfaces

- point-elastic PVC floor

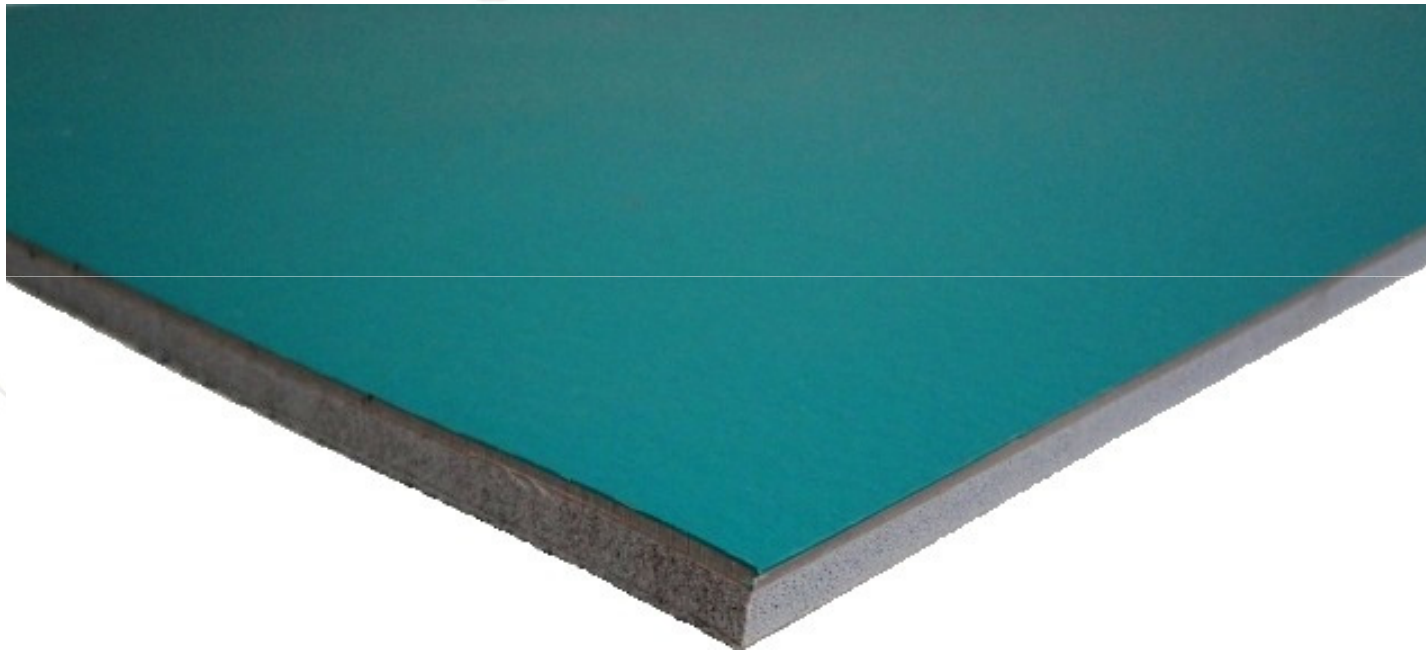
- sealed hardwood floor

Synthetic sports surfaces



Shock absorption:	39%
Vertical deformation:	2.3 mm
Thickness :	14.9 mm

Point-elastic PVC floor



Shock absorption:	28%
Vertical deformation:	1.1 mm
Thickness :	8.1 mm

Sealed hardwood floor



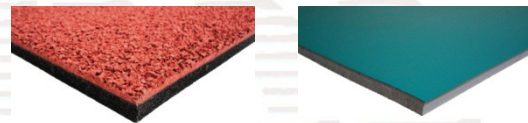
Slip resistance: 74 (dry)
Thickness : 21 mm

INTER

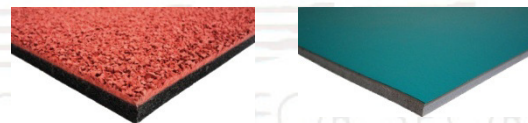
CIENCES

The following tests were conducted on the following samples:

Shock absorption:



Vertical deformation:



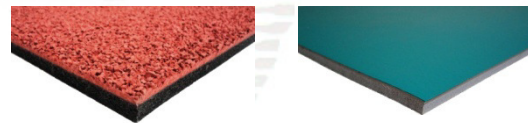
Thickness:



Slip resistance:



Tensile properties:



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INTERNATIONAL ASSOCIATION FOR SPORTS SURFACE SCIENCES

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Shock absorption - 3rd impact

R

Synthetic surface

EN 14808

Results submitted by participants

i.e., individual results x_{ik}

+ number of the test repetitions made by each lab (n_i)

+ within laboratory means (\bar{x}_i) and standard deviations (s_i)

+ results of tests for outliers

Number of reporting laboratories p^* : 21

Number of reported test results $\sum n_i$: 42

Lab Code No.	Test results in %						Statistical evaluation of the submitted test results x_{ik}			Outliers		
	Test replication No. (k)						n_i	\bar{x}_i	s_i	Cochran	Grubbs	$z > 2$
	1	2	3	4	5	6						
18	36,6	36,3					2	36,43	0,2475			
786	36,3	37,2					2	36,76	0,6187			
900	37,3	36,4					2	36,84	0,5834			
915	37,3	36,4					2	36,85	0,6364			
864	38,1	37,0					2	37,56	0,7955			
472	38,0	37,8					2	37,89	0,0884			
481	37,5	38,3					2	37,90	0,5657			
318	37,7	38,4					2	38,07	0,4844			
569	38,3	38,0					2	38,13	0,1768			
875	38,5	38,5					2	38,51	0,0283			
1	38,9	39,5					2	39,18	0,3889			
627	39,2	39,4					2	39,29	0,1591			
793	39,6	39,5					2	39,54	0,0884			
889	39,6	39,7					2	39,64	0,0530			
772	39,8	39,8					2	39,80	0,0000			
701	40,1	40,0					2	40,06	0,0884			
905	42,4	37,8					2	40,11	3,2350	**		
562	40,0	40,4					2	40,18	0,3182			
162	40,0	40,4					2	40,20	0,2828			
803	41,7	41,6					2	41,63	0,0707			
515	42,2	42,7					2	42,41	0,3359			X

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INTERPRETATION

ISP

Results of robust statistics			
Robust average: $x^* = 38,9$		assigned value for the proficiency assessment	
Robust standard deviation for the proficiency assessment: $s^* = 1,64$			
Number of repeat measurements necessary due to s_r/s^* -ratio: $n' = 1$		OK	see page 4 for the meaning of NOT OK
Standard uncertainty of the assigned value: $u_x = 0,44861$		OK	

Additional check of the test method accuracy			
Do the input data come from a normal distribution ?			YES
(The results listed below shall be considered as really justified only if the input data come from a normal distribution)			
General mean $\sum n_i x_{ik} / \sum n_i$	m	38,8	%
Repeatability variance	s_r^2	0,1455363	
Repeatability standard deviation	s_r	0,38149	%
Repeatability coefficient of variation	$CV\%_r$	0,982	%
Between-laboratory variance	s_L^2	2,5983125	
Between-laboratory standard deviation	s_L	1,61193	%
Between-laboratory coefficient of variation	$CV\%_L$	4,150	%
Reproducibility variance s_R^2	$s_r^2 + s_L^2$	2,7438487	
Reproducibility standard deviation	s_R	1,6565	%
Reproducibility coefficient of variation	$CV\%_R$	4,265	%
Repeatability limit	r	1,07	%
Relative repeatability limit	r_{rel}	2,8	%
Reproducibility limit	R	4,64	%
Relative reproducibility limit	R_{rel}	11,9	%
Number of participants included in the accuracy evaluation	p	20	
Number of tests included in the accuracy evaluation	$\sum n$	40	

Repeatability limit (r):

A value less than or equal to what the absolute difference between two test results obtained under repeatability conditions may be expected to be with a probability of 95%.



LAB 318

within the **same** test institute



LAB 318

Reproducibility limit (R):

A value less than or equal to what the absolute difference between two test results obtained under reproducibility conditions may be expected to be with a probability of 95%



LAB 318

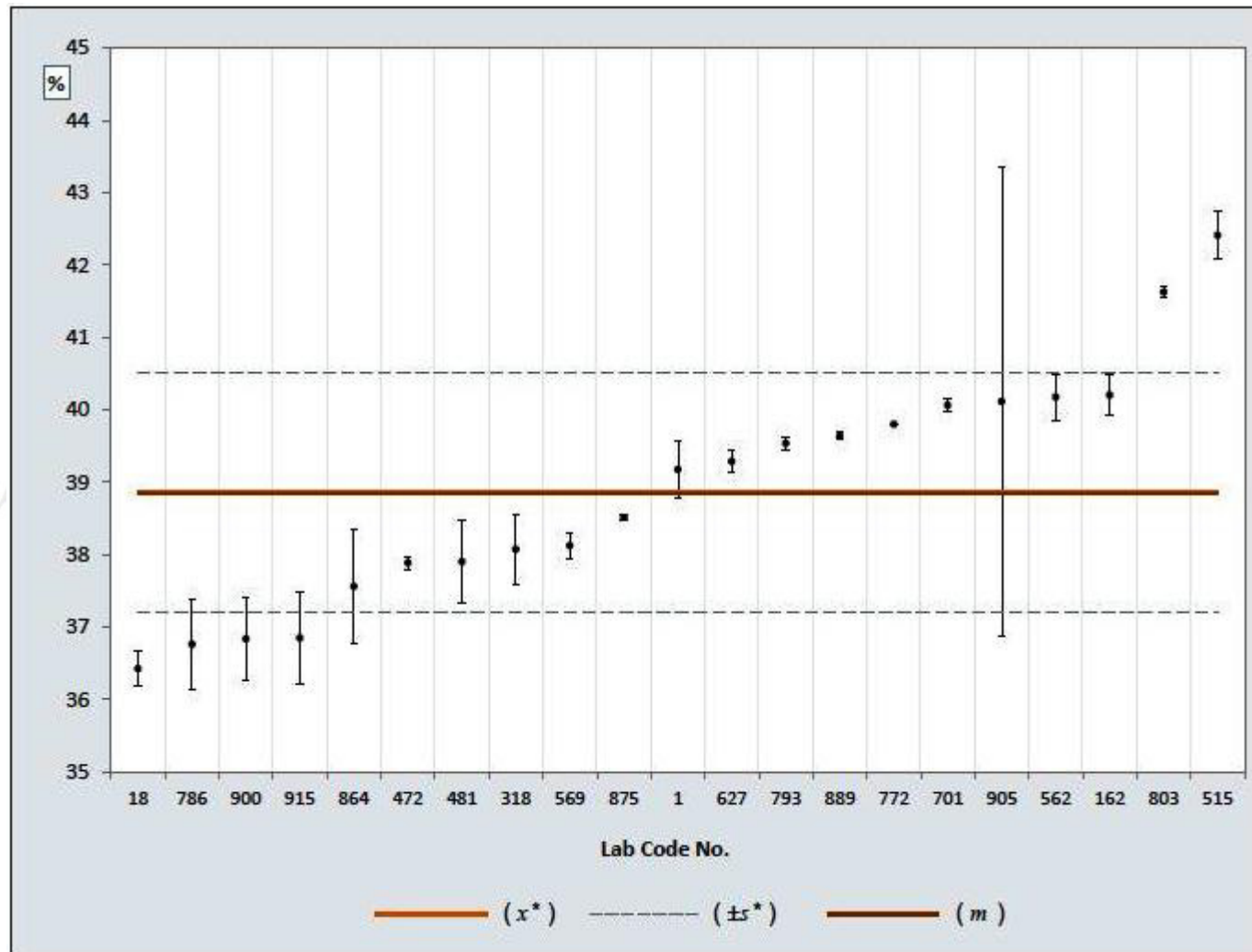
between **two** test institutes



LAB 875

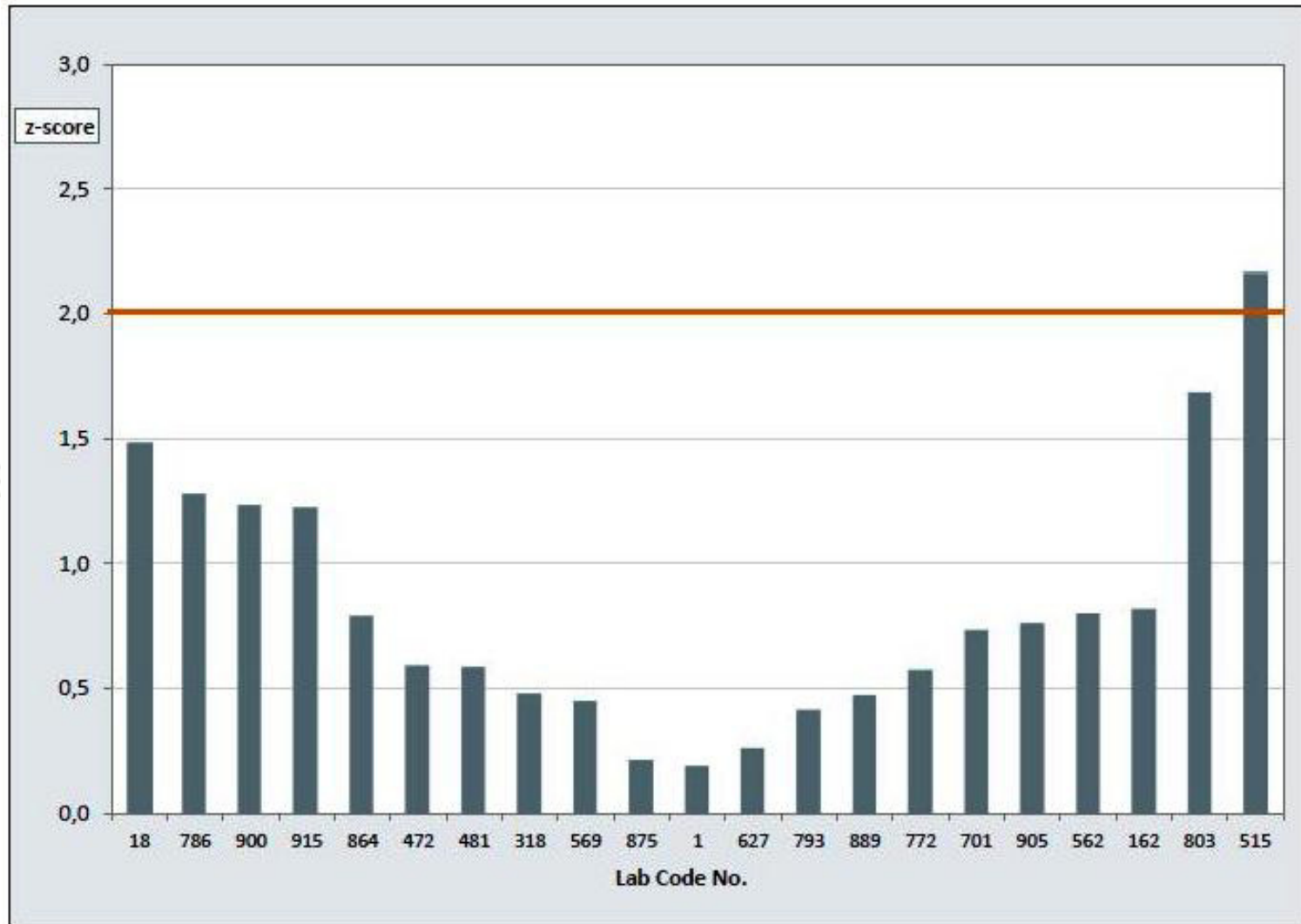
INTERPRETATION

ISP



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z-score:

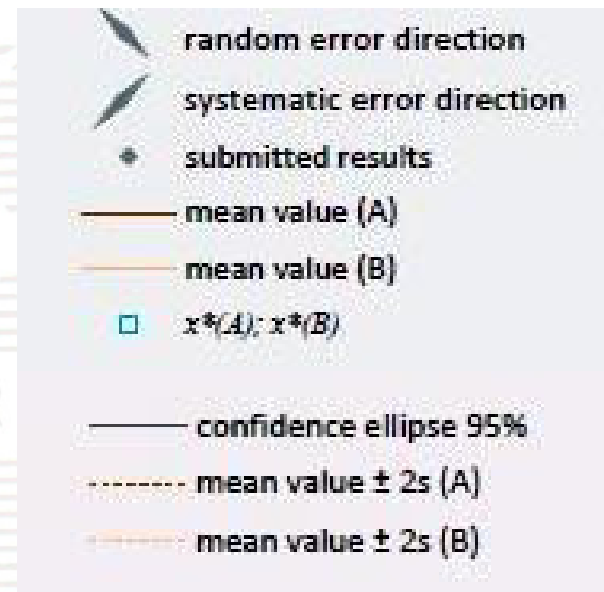
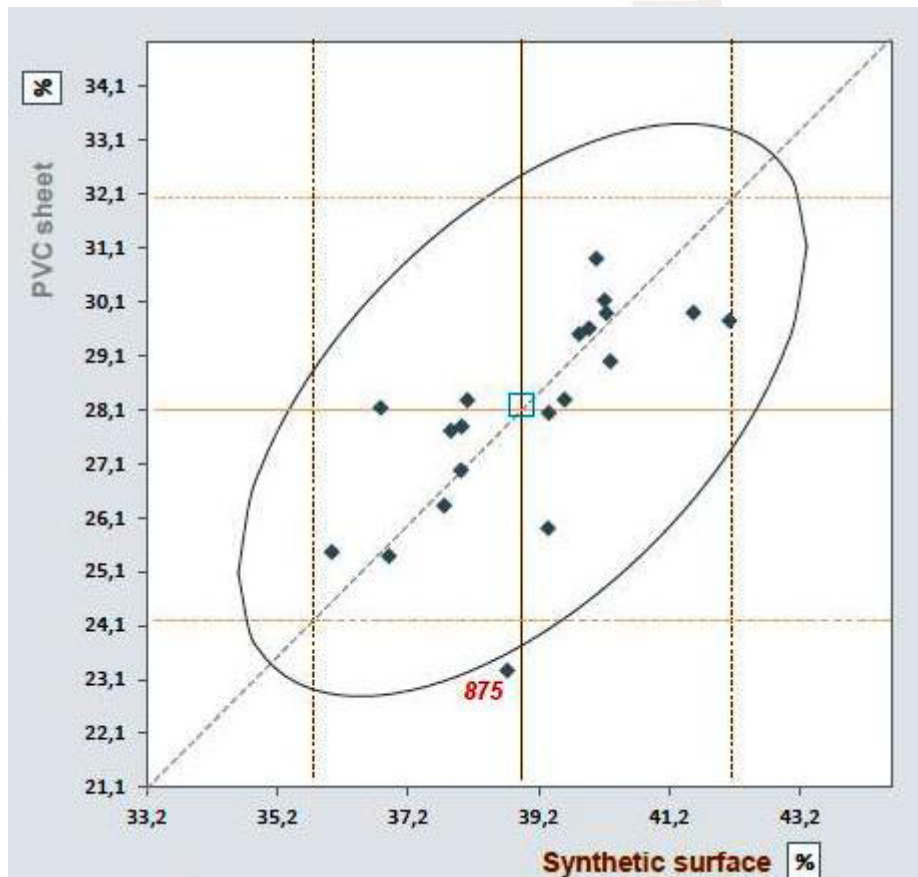
The z-score is a measure of the distance of an individual result from the mean; the scale unit is the standard deviation.

The resulting data is assessed as follows:

- $z = \leq 1$ *the performance of the laboratory is **very good***
- $z = 1 - 2$ *the performance of the laboratory is **satisfactory***
- $z = 2 - 3$ *the performance of the laboratory is **questionable***
- $z = \geq 3$ *the performance of the laboratory is **unsatisfactory***

INTERPRETATION

ISP



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Selected test methods

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Interpretation of the general results


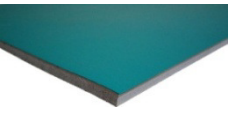
Evaluation of the general results

Discussion

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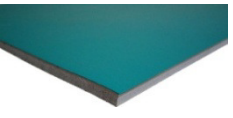
Determination of vertical deformation

Number of test laboratories: 21

Sample	Impact	General mean (<i>m</i>)	Repeatability limit (<i>r</i>)	Reproducebility limit (<i>R</i>)
	2nd	2.3 mm	0.2 mm (9.1%)	0.7 mm (29.5%)
	3rd	2.2 mm	0.2 mm (8.5%)	0.6 mm (27.9%)
	2nd	1.2 mm	0.1 mm (9.6%)	0.7 mm (63.0%)
	3rd	1.1 mm	0.1 mm (9.3%)	0.7 mm (65.1%)



Determination of shock absorption

Number of test laboratories: 21

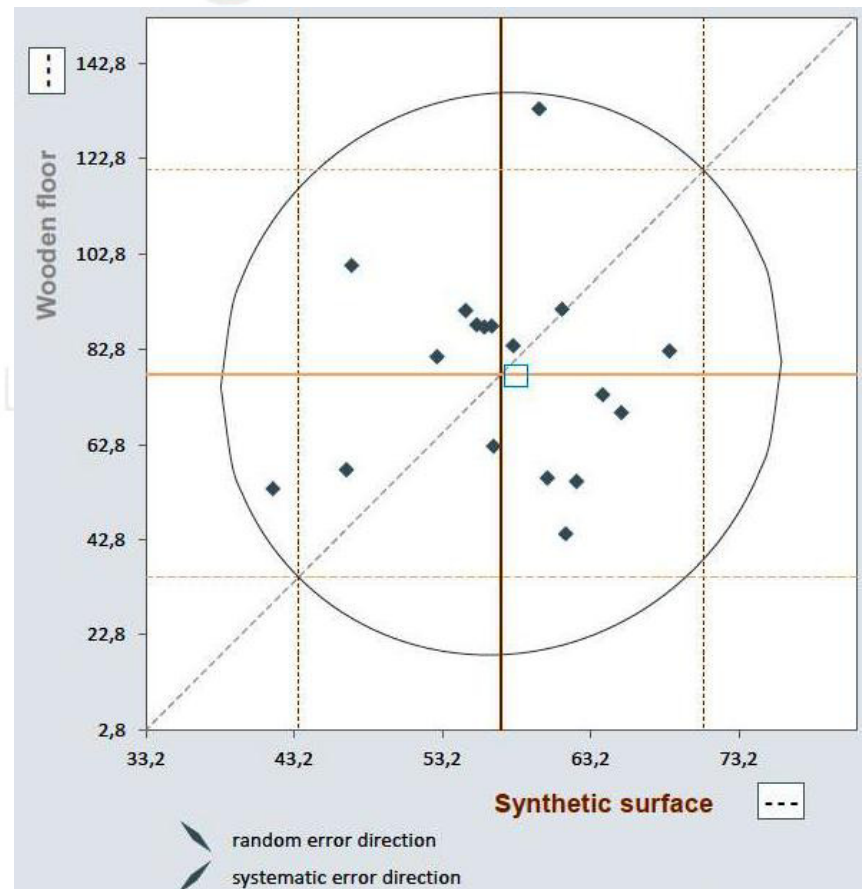
Sample	Impact	General mean (<i>m</i>)	Repeatability limit (<i>r</i>)	Reproducebility limit (<i>R</i>)
	2nd	38.9%	1.3% (3.4%)	4.6% (11.9%)
	3rd	38.8%	1.1% (2.8%)	4.6% (11.9%)
	2nd	28.1%	1.5% (5.2%)	5.6% (19.8%)
	3rd	28.0%	1.5% (5.5%)	5.6% (19.1%)

Determination of slip resistance

Number of test laboratories: 19

Sample	Direction	Condition	General mean (<i>m</i>)	Repeatability limit (<i>r</i>)	Reproducebility limit (<i>R</i>)
	diagonal	wet	60	6.3 (11.1%)	18.8 (33.0%)
	90°		57	6.7 (11.8%)	19.7 (34.6%)
	diagonal	dry	78	10.1 (13.0%)	60.3 (77.6%)
	90°		77	3.3 (4.3%)	69.7 (90.6%)



Determination of slip resistance



ISO 17025 laboratories only (ofi - 30.10.2012)


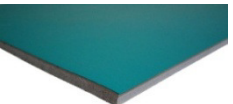
Determination of slip resistance

Number of test laboratories: 7 - 8

Sample	Direction	Condition	General mean (<i>m</i>)	Repeatability limit (<i>r</i>)	Reproducebility limit (<i>R</i>)
	diagonal	wet	58	6.3 (10.9%)	17.4 (29.9%)
	90°		58	6.9 (12.0%)	19.0 (33.0%)
	diagonal	dry	71	2.3 (3.2%)	45.2 (63.4%)
	90°		76	3.0 (4.0%)	53.5 (70.8%)

Determination of thickness (ofi – 30.10.2012)

Number of test laboratories: 15 - 16

Sample	Impact	General mean (<i>m</i>)	Repeatability limit (<i>r</i>)	Reproducebility limit (<i>R</i>)
	overall	14.64 mm	0.46 mm (3.2%)	2.71 mm (18.5%)
	layer	5.71 mm	0.28 mm (5.0%)	10.79 mm (189.0%)
	overall	8.11 mm	0.08 mm (0.9%)	0.21 mm (2.5%)

Thickness - layer

Synthetic surface

EN 1969

Results submitted by participants

i.e., individual results x_{ik}

+ number of the test repetitions made by each lab (n_i)

+ within laboratory means (\bar{x}_i) and standard deviations (s_i)

+ results of tests for outliers

Number of reporting laboratories p^* : 16

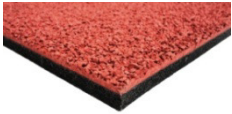
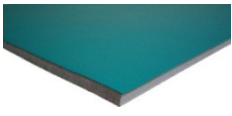
Number of reported test results $\sum n_i$: 32

Lab Code No.	Test results in mm						Statistical evaluation of the submitted test results x_{ik}			Outliers		
	Test replication No. (k)						n_i	\bar{x}_i	s_i	Cochran	Grubbs	$z > 2$
	1	2	3	4	5	6						
481	3,32	3,32					2	3,323	0,0014			
515	3,40	3,75					2	3,575	0,2475			
39	4,06	3,30					2	3,683	0,5388	**		
772	3,70	3,70					2	3,698	0,0028			
889	4,00	3,88					2	3,937	0,0834			
247	4,13	3,85					2	3,990	0,1980			
875	4,02	4,03					2	4,026	0,0085			
864	4,02	4,18					2	4,101	0,1089			
472	4,46	4,25					2	4,358	0,1499			
900	4,46	4,43					2	4,445	0,0156			
803	4,61	4,59					2	4,599	0,0099			
800	4,77	4,76					2	4,765	0,0071			
162	4,80	4,78					2	4,790	0,0141			
986	5,92	5,95					2	5,935	0,0240			X
701	14,55	14,41					2	14,482	0,0990			X
1	15,63	15,66					2	15,644	0,0226		*	X

Tensile Properties

Determination of maximum strength

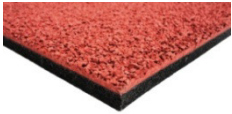
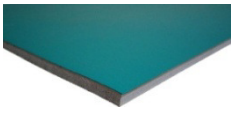
Number of test laboratories: 15

Sample	Direction	General mean (<i>m</i>)	Repeatability limit (<i>r</i>)	Reproducebility limit (<i>R</i>)
	I	656 kPa	44 kPa (6.7%)	127 kPa (19.4%)
	II	661 kPa	56 kPa (8.5%)	116 kPa (17.5%)
	I	2458 kPa	165 kPa (6.7%)	286 kPa (11.6%)
	II	2433 kPa	212 kPa (8.7%)	324 kPa (13.3%)

Tensile Properties

Determination of tensile strength at break

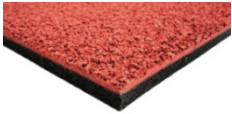
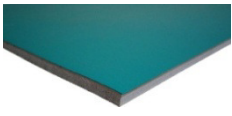
Number of test laboratories: 14

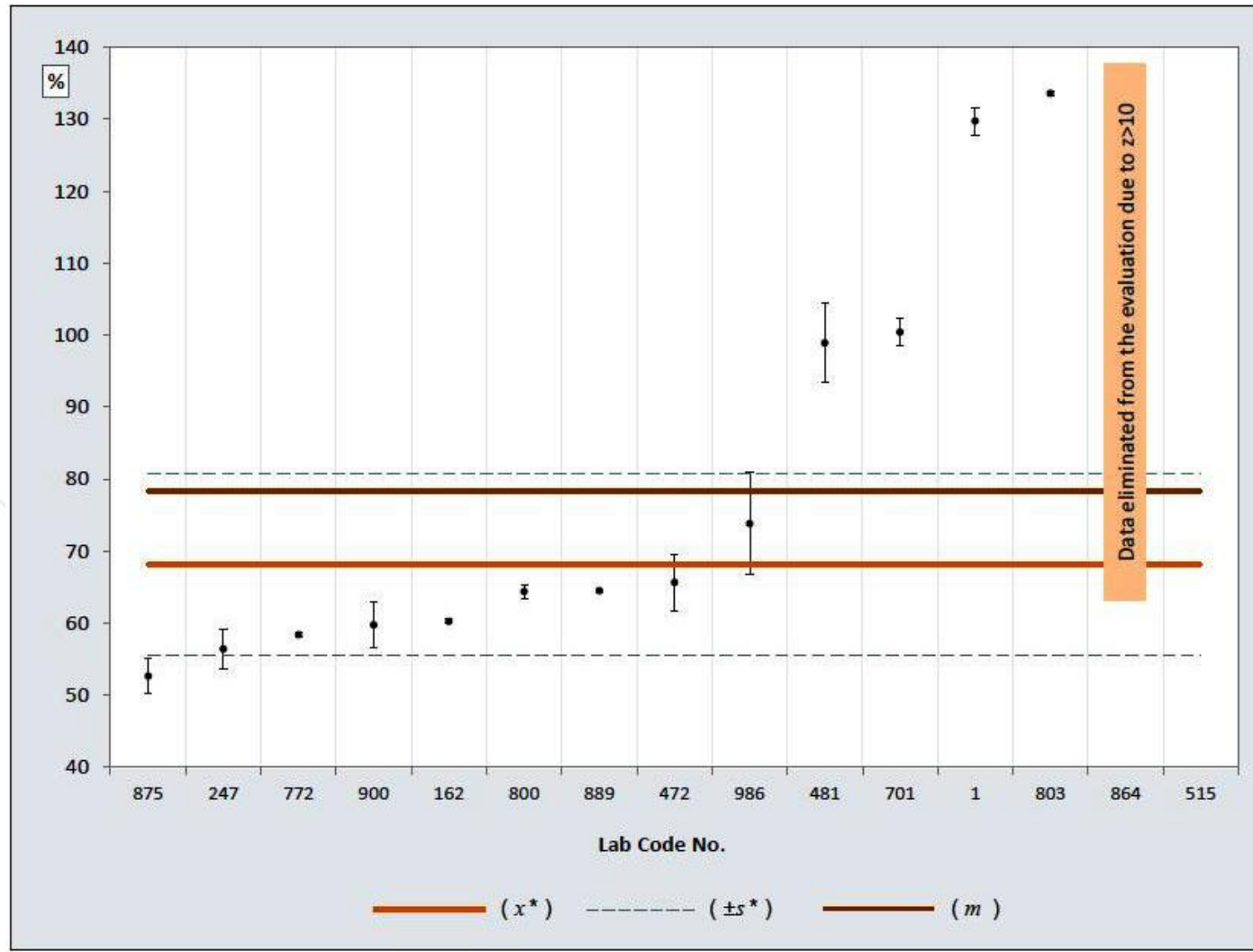
Sample	Direction	General mean (<i>m</i>)	Repeatability limit (<i>r</i>)	Reproducebility limit (<i>R</i>)
	I	605 kPa	52 kPa (8.6%)	152 kPa (25.2%)
	II	604 kPa	60 kPa (9.9%)	165 kPa (27.4%)
	I	1986 kPa	146 kPa (7.3%)	430 kPa (21.6%)
	II	1988 kPa	287 kPa (14.4%)	434 kPa (21.8%)

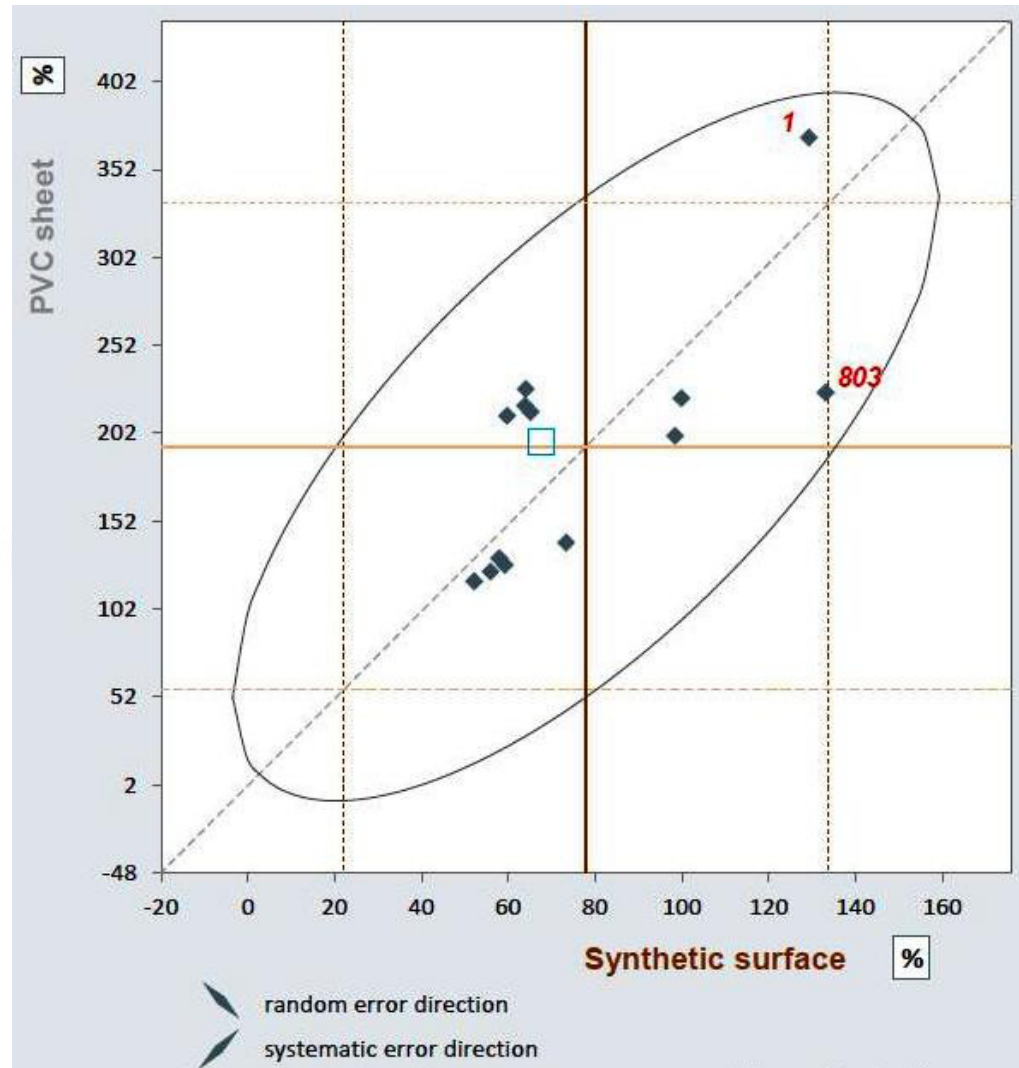
Tensile Properties

Determination of elongation at break

Number of test laboratories: 14

Sample	Direction	General mean (<i>m</i>)	Repeatability limit (<i>r</i>)	Reproducebility limit (<i>R</i>)
	I	78.3%	8.8% (11.2%)	78.6% (100,3%)
	II	77.4%	6.8% (8.8%)	74.6% (96.5%)
	I	212.6%	41.9% (19.8%)	268.5% (126.3%)
	II	190.5%	34.2% (18.0%)	171.9% (90.25%)





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The variations in the results could rely on the following reasons:

- misunderstanding of the instructions
- undetailed instructions
- undetailed information of the standard
- calibration of the used test equipment
- unsuitable test equipment
- inappropriate test method
- ISO 17025 accreditation of the test institutes

How do we proceed with this information?

To use this data properly, all the results need to be broken down.

- additional information have to be supplied by the laboratories
- false results need to be excluded or corrected
- additional testing need to be conducted
- recalculation of the results under the following aspects:
 - ISO 17025 accreditation of the test institue
 - ISO 17025 accreditation for the test method
 - exclusion of all “outliener”

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The following tests will be conducted on the following samples :

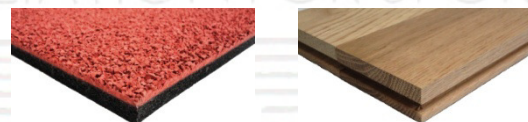
Critical fall height:

Playground tile

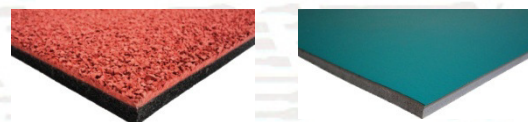
Abrasion resistance:



Rotational friction:



AAA:



Resistance to impact:



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Thank you for your attention

ISP

Dennis Frank

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