I.S.S.S.
International Association for Sports Surface Sciences
Attn. Mr. Hans-Jörg Kolitzus
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Vienna, 2010-04-20
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Ref.: "Precision of the results of methods for sports surfaces in ***ofi***-PTS2010 "

Dear Mr. Kolitzus,
I have been asked by you to provide an expert opinion on the following question:

What can be said about the precision of the results of methods for sports surfaces in ofi-PTS2010?

All measurement techniques provide us with results exhibiting different uncertainties. Each test result deviates – more or less – from the "true value". The specific test method precision is basically an inherent property of the method as such, but it varies with test conditions and – frequently – also with the type of material tested. Thus, the uncertainty of the test result, which determines whether two differing test results must be judged as equal or as significantly different, is affected by the test method precision.

For statistical reasons, the higher the number of test repetitions, the higher the precision of the result, when computed as the mean value of repeated measurements. For instance, weighing is a measurement which is generally considered 'very precise'. Therefore, it is not usual to repeat the weighing of one and the same object to obtain a more reliable result.

Other measurement techniques (test methods) are less precise, so that repeating of the test procedure (measurement) on the same sample is indicated. If such a test procedure is standardized, the repetition of the single tests and evaluation of a mean value (or e.g. median) is commonly required by the standard. In this case, the measure

of the precision is usually computed as a standard deviation of the test results in repeated experiments.

In the mechanical testing of plastics, often a minimum of 5 specimens is tested in accordance with the respective standard (e.g. tensile test or flexural test).

Recently updated international and national standards on test methods shall include a special chapter dealing with precision. The respective data is taken from results of so called "round robins", i.e., interlaboratory comparison tests conducted by a number of laboratories on identical sample material like the ***ofi***-PTS. The following characteristic values are always quoted in the respective part of each standard as a measure of the test method precision:

- s_r … "repeatability standard deviation" obtained by pooling the within-laboratory standard deviations of the test results from all of the participating laboratories
- s_R … "reproducibility standard deviation" which includes the repeatability term (s_r) and the dispersion of the laboratory means expressed as related standard deviation s_L
- r … within-laboratory critical interval between two test results (i.e. "repeatability limit"; $r = 2{,}8 * s_r$)
- R … between-laboratories critical interval between two test results (i.e. "reproducibility limit"; $R = 2{,}8 * s_R$)

With regard to the "reproducibility limit R", the following statement applies:
In comparing two test results for the same material obtained by different operators using different equipment on different days, those test result should be judged as not equivalent if they differ by more than the R-value. This applies between different laboratories or between different equipment within the same laboratory. Any judgment based on the R-value would have an approximate 95 % probability of being correct.

In the last proficiency test schemes, ***ofi***-PTS2010, the evaluated methods for sports surfaces were:

- Determination of vertical ball behaviour (EN 12235:2004), #109 (***ofi***-method no.)
- Determination of vertical deformation (EN 14809:2005), #110
- Determination of shock absorption (EN 14808:2005), #111

We have had 18 (#109), 19 (#110) and 20 (#111) participants for this test and the relative repeatability limits r_{rel} respectively the reproducibility limits R_{rel}, that considers the determination of a sample in different test laboratories were as following:

- Determination of vertical ball behaviour (EN 12235:2004), #109

		r_{rel} [%]	R_{rel} [%]
SS1	hockeyball	3,4	18,6
	football	2,2	4,2
	basketball	2,3	5,3
SS2	hockeyball	5,9	20,0
	football	2,6	2,8
	basketball	3,0	5,8
ST3	hockeyball	8,9	22,8
	football	3,3	11,6
	basketball	3,1	18,4
ST4	hockeyball	23,3	41,0
	football	11,0	16,8
	basketball	9,2	24,7

- Determination of vertical deformation (EN 14809:2005), #110

		r_{rel} [%]	R_{rel} [%]
SS1	2nd impact	9,8	25,0
	3rd impact	7,5	25,7
SS2	2nd impact	37,8	37,8
	3rd impact	37,5	37,5
ST3	2nd impact	7,4	19,6
	3rd impact	6,4	20,0
ST4	2nd impact	18,5	44,2
	3rd impact	17,9	47,4

- Determination of shock absorption (EN 14808:2005), #111

		r_{rel} [%]	R_{rel} [%]
SS1	2nd impact	4,3	15,2
	3rd impact	4,0	14,4
SS2	2nd impact	10,7	12,4
	3rd impact	11,2	13,4
ST3	2nd impact	2,2	5,3
	3rd impact	5,9	7,9
ST4	2nd impact	9,6	14,9
	3rd impact	10,9	13,3

Standards and other documents dealing with this matter:

1. ISO 5725 (Part 1 to 6): "Accuracy (trueness and precision) of measurement methods and results"
2. ISO/TS 21748: "Guidance for the use of repeatability, reproducibility and trueness estimates in measurement uncertainty estimation"
3. "Guide to the Expression of Uncertainty in Measurement" (GUM); ISO 1995; ISBN 92-67-10188-9
4. EA Guideline EA-4/16 " Expression of Uncertainty in Quantitative Testing"
5. ISO 10576 "Statistical Methods – Guidelines for the evaluation of conformity with specified requirements – Part 1: General principles"
6. ASTM E 177: "Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods"

Dr. Thomas Karall

Head of the group "Physical Testing" and ***ofi***-PTS