Understanding and Applying Standards To Indoor Sport/Play Surfaces

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Understanding Existing Standards

North American Focus

- **Mandatory / Compulsory Standards**
  - ➔None in North America
- **Voluntary Standards**
  - ➔DIN 18032-2
    - ✔ Both the 1991 Standard[A] and the 2001 Pre-Standard[B]
  - ➔ASTM F-2117[C]
    - ✔ Vertical Ball Rebound Test Method

- **Focus: Most common standard applied to indoor sports surfaces in North America**
  - ➔DIN 18032-2

Mechanical Properties

Ball Rebound	Rolling Load	Area Indentation

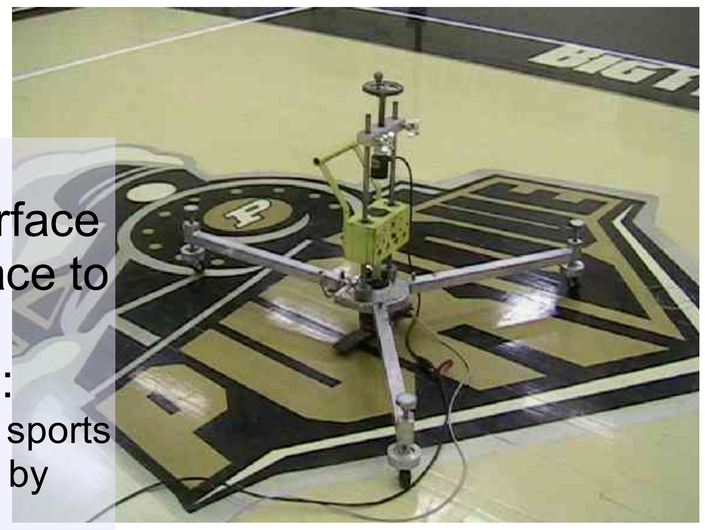
Biomechanical Properties

Force Reduction	Vertical Deflection	Slip Resistance

Overview

- **Ball Rebound**
  - ➔Indicates 'Playability' of the surface
  - ➔Compares rebound height on surface to concrete
  - ➔A ball rebound of 94% means:
    - ✔ The rebound height produced on the sports floor is 94% of the height produced by concrete
    - ✔ The rebound height produced on the floor is 6% lower than the rebound height produced on concrete

- **DIN vs. ASTM Ball Rebound**
  - ➔ Basketball results are presented in the same format
  - ➔ DIN measures to top of ball, ASTM measures to bottom of ball
  - ➔ DIN is a method as well as a performance standard
    - ✔ It calls for minimum performance levels
  - ➔ASTM is a method
    - ✔ It does not set required performance levels



- **Force Reduction**
  - ➔Indicates comfort level of the surface
  - ➔Compares impact force on surface to concrete
  - ➔A force reduction of 56% means:
    - ✔ The impact force produced on the sports floor is 44% of the force produced by concrete
    - ✔ The impact force produced on the floor is 56% lower than the force produced on concrete

- **Vertical Deflection**
  - ➔Indicates how the floor deflects during lower extremity impacts
  - ➔Deflection value is normalized to an impact of 1500 N (335 lb.)
  - ➔A vertical deflection of 2.5 mm means:
    - ✔ The floor would deflect 2.5 mm during an impact with a peak for of 1500 N

- **Rolling Load**
  - ➔Indicates how well the *surface* of the system will withstand loads common to Germany
  - ➔1500 N or 1000 N (335 lb. or 200 lb.) applied through a single steel wheel
  - ➔If no damage, floor passes

- **Area Indentation**
  - ➔Indicates how well vibrations are contained by the sports surface system
  - ➔An area indentation of 14% means:
    - ✔ That 85% of the vibrations produced at impact have been removed after traveling 500 mm through the sports surface

- **Slip Resistance / Friction**
  - ➔Indicates traction properties of playing surface
  - ➔Required to be between 0.4 – 0.6 2001 Pre-Standard
  - ➔Required to be between 0.5 – 0.7 1991 Standard

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References:

[A] DIN 18032-2 Standard, Sports Halls – Halls for Gymnastics, games and multi-purpose use – Part 2: Sports floors, requirements, testing. Beuth Verlag GmbH Berlin, Germany, 1991

[B] DIN 18032-2 Pre-Standard, Sports Halls – Halls for Gymnastics, games and multi-purpose use – Part 2: Sports floors, requirements, testing. Beuth Verlag GmbH Berlin, Germany, 2001

[C] ASTM F-2117 Standard test method for vertical rebound characteristics of surface/ball systems. ASTM, West Conshohocken, PA, USA, 2001

Applying Existing Standards

North American Focus

- **Required Performance Levels[A,B]**

	1991 Standard	2001 Pre Standard
Ball Rebound	90% Min	90% Min*
Force Reduction	53% Min	53% Min*
Vertical Deflection	2.30 mm Min	2.30 mm Min*
Area Indentation	15% Max	15% Max (Point)* 20% Max (Dir)**

* 2001 Pre-Standard applies limits to individual points

** 2001 Pre-Standard applies limits to all 4 directions

- **Use Within Specification**
  - ➔The voluntary nature means that consumers decide if, when and how to use standards for their projects
    - ✔ Require that surface meet all of the requirements
    - ✔ Require that surface meet some of the requirements
    - ✔ Require that the surface be tested
    - ✔ Completely disregard during the selection process

- **If you choose a system meeting *all* of the criteria**
  - ➔Commonly marketed as “DIN Certified”
    - ✔ Typically the lab tests are certified by an independent testing company
  - ➔Require a suitability report issued by the testing company to be included in the project bid submittals
    - ✔ Typically these documents are 5-7 pages long
- **If you choose a system meeting *some* of the criteria or a system that has simply been tested**
  - ➔Commonly marketed as “DIN Tested”
    - ✔ May have been tested by an independent testing company
  - ➔Require a test report issued by the testing company to be included in the project bid submittals
    - ✔ Typically these documents are 2-4 pages long

- **Lab Testing is an *indication* not a *guarantee* of actual installation performance levels**
  - ➔Many architects assume they ensure performance by selecting 'Certified' or 'Tested' products
  - ➔Only field testing of the finished installation can ensure that the specified performance levels were met
    - ✔ When performance is critical to the product selection, the specification should stipulate field testing. It should define who and how testing is to be paid for and any penalties should the product fail to meet the specification

Strengths and Weaknesses of Using DIN 18032-2 within North America

- **Strengths**
  - ➔Provides a mechanism for comparing indoor surface performance
    - ✔ Provides a repeatable method
    - ✔ Provides a reliable method
  - ➔It is an internationally recognized standard
    - ✔ Used in many countries where domestic standards do not exist (ex: North America)
    - ✔ Adapted but used as the foundation for several national standards
  - ➔Most criteria can be evaluated in the lab and field
  - ➔Has improved cushioning of sports/play surfaces in North America since introduction

- **General Weaknesses**
  - ➔It is often assumed that the lab testing equates to performance in the field
  - ➔Developed based on German cultural and political preferences that may or may not be appropriate within the North American market
  - ➔No North American user group, test lab or manufacturer has direct input into the development or modification of DIN standards
  - ➔Uniform performance is not seriously addressed in either version

- **Specific Weaknesses**
  - ➔Rolling Load
    - ✔ Loading is insufficient to guarantee sports surface system compatibility with several common North American loads
      - · Large bleachers (15 rows or greater)
      - · Some portable goal units
      - · Scissor-lifts commonly used for maintenance
  - ➔Slip Resistance / Friction
    - ✔ Cleaning solutions may change friction through chemical reaction or by leaving residue
    - ✔ Recoating by local contractors may result in a surface that does not comply with the standard
    - ✔ Local ordinances and laws sometimes prohibit the use of some finishes. Meaning that including slip resistance on a general suitability test report for all of North America is inappropriate

For more information regarding standards for indoor sports surfacing, using DIN 18032-2 within North America visit our website library at www.asetservices.com/library.html

An Introduction To Uniformity

- **3 Stages of Lower Extremity Impacts**
  - 'Pre-sponse'
    - Occurs before impact
    - The athlete unconsciously anticipates the stiffness of the surface by pre-setting muscle and joint stiffness through a variety of biomechanical mechanisms[D]
  - 'Pre-flex' and Passive Dynamics[E]
    - Starts immediately after contact with the surface. This portion of the landing is not under control of the nervous system.
    - The 'pre-flexes' allow the body to react to changes in surface stiffness without delay.
  - Response
    - Starts approximately 0.05 seconds after contact.
    - The brain is now able to adjust muscle stiffness and kinematics in response to the stiffness of the surface.

- **Significance of Uniformity**
  - During the 'Pre-sponsive' phase the athlete's body is conditioned to and already reacting to the expected surface stiffness. This conditioning is rapidly learned from previous impacts.
  - When the actual and the expected surface stiffnesses differ, 'Pre-flexes' allow the body to immediately respond to these differences. These pre-flexes tend to regulate and control the magnitude of the forces generated during impact[E].
  - In instances where the surface is sufficiently uniform, the need for and the magnitude of corrections made through the 'pre-flexive' responses should be minimized.
  - While research is focusing on the biomechanics of impacts, intuition allows these findings to be applied to other portions of activity (ex. ball rebound)

- **Uniformity Index Proposal**
  - Biomechanics and intuition support that uniform performance from sport/play surfaces is important
  - This section outlines a proposal to quantify uniformity
  - Key Features
    - Uses an open-source model (i.e. Not patented)
    - Uses readily available data
    - Provide a ranking between 0 and 100 with 100 being considered uniform

- **Uniformity Goal**
  - The ideal goal is a perfectly uniform sports surface,
  - However a more practical goal is to define 'uniform' at a level were athletes feel, perceive and react uniformly

- **Selection of Uniformity Criteria**
  - It was decided to use the DIN Force Reduction criteria to evaluate uniformity
    - Force Reduction is related to ball bounce and vertical deflection[F]
    - Force reduction tests are relatively fast and easy
    - The duration of impacts during force reduction correspond to the 'pre-flexive'/passive phases of landing

- **Establish Allowable Deviations**
  - A finite difference in force reduction will be necessary for the athlete to 'feel' the change and for significant differences to be measurable
  - A threshold of ±2% will be used until experiments provide evidence that it should be changed
    - Area indentation can be viewed as attempting to ensure that the surface stiffness changes by less than 15% during close activity
    - Using mechanics, it is estimated that a 15% change in the stiffness of the surface approximately equates to a 4% change in force reduction

- **Develop Numeric Index**
  - The standard deviation could be used on its own to indicate uniformity, but that does not result in a 0-100 scale
  - It is purposed that the standard deviation be used to estimate the percentage of the sport surface which will produce force reduction levels within ±2% of the average level
    - This is accomplished by assuming a normal distribution of force reduction values around the average value

- **Examples**
  - The following example is based on laboratory testing results
    - The uniformity indexes presented below were computed using actual data
    - The average force reductions have been adjusted by random amounts to preserve the identity of individual test samples

Sample	Force Reduction	Uniformity Index	Level Of DIN Compliance
1	57.3%	83	2001Certified
2	56.2%	88	1991Certified
3	52.2%	98	Tested

    - Sample 2 (1991 standard) was found to be slightly more uniform than sample 1 (2001 pre-standard)
    - Sample 3 failed to meet either version of DIN 18032-2 but was more uniform than either of the other samples;

- **Example Uses**
  - To allow the most uniform system with a given force reduction or certification level to be selected
  - To establish scientific basis for accepting equal systems
    - The above data might allow a system certified under the 1991 standard as equivalent or superior to one certified under the 2001 standard (see Samples 1 and 2 above)
    - The data above might also allow a floor with performance levels which are marginally outside of those allowable under DIN to be included or considered in the process (See sample 3 above)

References:

[D]Dietz V. et al. Neuronal mechanisms of human locomotion. J Neurophysiol 42: 1212-1222, 1979.

[E],Moritz C. and Farley C. Passive dynamics change leg mechanics for an unexpected surface during human hoping. J Appl Physiol 97: 1313-1322, 2004

[F]Elliott, et al. Relationships between selected parameters for the evaluation of hardwood sports surfaces. Proceedings of the 21st Annual Meeting of The American Society of Biomechanics, pp. 26-27, 1997