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The Performance Criteria of DIN 18032 Part II

This article is a summary of the performance criteria from the DIN standard 18032 part II commonly promoted in North America. A description of each criteria and the calculations involved are included. The performance limits are not presented in this article because the performance criteria have different limits depending upon the construction of the sports surface system.

DIN 18032 Part II measures a variety of performance sports surface characteristics. This article has grouped the performance criteria commonly marketed in North America into two main categories: Mechanical Criteria, and Biomechanical Criteria.

Definitions:

- Mechanical properties describe the mechanical properties of the sports surface such as strength and flexibility.
  - Ball Rebound - Liveliness of sports surface
  - Rolling Load Behavior - Ability of sports surface to withstand general loads common in Europe
  - Area Indentation - The ability of the system to contain impact energy to a small area.
- Biomechanical properties describe features that clearly represent interfaces between the athlete and the sports surface.
  - Force Reduction - The ability of the sports surface to reduce forces during impacts
  - Slip Resistance - An estimate of the friction properties of the sports surface.
  - Vertical Deflection - The ability of the floor to deflect during an athletes impact.

1. Mechanical Properties

The following properties describe the mechanical properties of the sports surface, and are not considered to provide clear biomechanical advantages.

1.1. Ball Rebound

Ball rebound is a criterion that evaluates the suitability of the sports surface for basketball. This property provides a numeric estimate for the 'liveliness' of the sports surface system.

The ball rebound property is the rebound height obtained on the sports surface expressed as a percentage of the rebound height obtained on concrete. The following equation is used to calculate ball rebound*[1,2]*:

$$BR = \frac{h_{sportsurf}}{h_{concrete}}100$$

Where $h_{sportsurf}$ is the rebound height obtained on the sports surface (measured in meters), $h_{concrete}$ is the rebound height obtained on concrete (measured in meters), and BR is the ball rebound expressed in (%). Rebound height is measured from the top of the floor to the bottom of the ball.

Ball rebound values tend to range from 80%-100%, depending on the inflation pressure, room temperature, and ball construction and system construction. Higher values represent sports surfaces that produce higher rebound heights, and would probably be described as being more 'lively'.

Cultural preferences and the intended uses may result in desires for very high ball rebound characteristics. As an example, a facility designed primarily for competition may choose to specify a very high ball rebound value to promote a fast speed of play.

1.2. Rolling Load Behavior

The rolling load characteristic examines the ability of a sport surface system to withstand the loads associated with sports surface use in Germany and Europe.

The rolling load testing is conducted with load of either 1500 N (335 lbs) or 1000 N (223 lbs) depending on the sports surface classification*[1,2]*. Loading is applied through a single wheel. This is the only criterion with a subjective (non numeric) evaluation. The surface and the entire system must show no sign of damage after the tests are complete. No method is specified to evaluate or quantify the damage that might have occurred during the testing. Sports surfaces are either given a ‘pass’ or ‘fail’ rating.

Sports surfaces are generally used much differently in North America than in most of Europe. As such North America sports surfaces are often subjected to loads that greatly exceed those applied during this test. This test is not an indicator of how the sport surface system will withstand relatively high loads (portable back-stops, greater than 10-15 rows of bleachers, and portable maintenance lifts) common in North America.

While rolling load capability is an important property of a sports surface system, ASET Services, Inc. has decided not to include it in suitability reports because the loads associated with it do represent some of the most common loads found in North American facilities. Specifiers and managers are encouraged to thoroughly discuss the loads that the system must support with their sports surface provider to ensure compatibility.

1.3. Area Indentation

Area indentation provides a measure of how well the sports surface is able to contain the energy transferred from the athlete to the surface during the impact. Sports surfaces that transmit impact energy over a large area perform poorly in this test, while those that contain the impact energy to a small area perform well.

Area indentation is often the hardest of the criterion to describe. It is intended to ensure that activities at one point on the floor have a minimal effect on activities at another point on the floor. As an example consider two athletes attempting to gather a rebound after a basketball shot. The floor should prevent the landing of athlete #1 from effecting the takeoff, or landing of athlete #2.

Area indentation is evaluated at the same time Vertical Deflection is evaluated. Deflections 500 mm (20 inches) from the point of impact are compared to the vertical deflection value. In a wood floor system, these locations of these points are based on the direction of the wood flooring strips. One point forms a line through the distant point and the point of impact that is parallel to the wood flooring strips. The other point forms a line through the impact point and the distant point that is perpendicular to the wood flooring strips. The points are illustrated in the following figure.

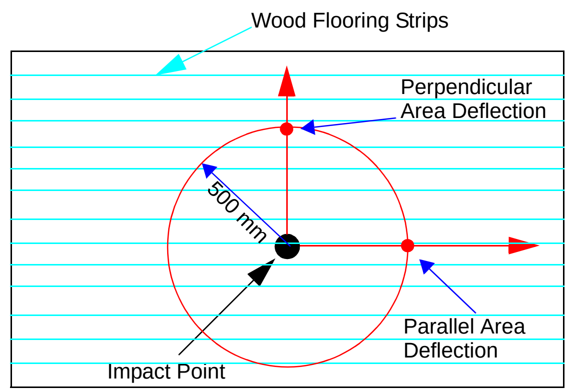

Figure 1: Illustration of area deflection point locations.

The following calculation is performed for deflections collected both parallel and perpendicular to the flooring boards 500 mm from the point of impact*[1,2]*.

$$AI = \frac{f_{500}}{StVv}100$$

Where f_{500} is the deflection 500 mm from the point of impact (mm), StVv is the vertical deflection (discussed in section 2.2 at the point of impact (mm), and AI is the area indentation expressed in percent. Area indentation is computed for each point to yield area indentation parallel, perpendicular and average.

This criterion is also the most controversial criterion in this standard. There are many different opinions on the importance of Area Indentation between European countries. For more information refer to *The Performance Requirements of DIN 18032 Part II* (Document Number DIN -002).

2. Biomechanical Properties

The following properties are more closely related to athlete/surface interaction than with merely providing mechanical characteristics of the sports surface.

2.1. Force Reduction

Force Reduction is also commonly referred to as shock absorption. Force reduction measures the ability of the sports surface to reduce maximum impact forces compared to impacts on concrete. This property is a strong indicator of the level of comfort that will be provided by the sport surface system to athletes.

This property has the strongest biomechanical foundation of the properties in the DIN 18032 standard. The impact duration is developed to be very short and approximately equal to the time when 'passive' impact peaks commonly occur. 'Passive' impact peaks get their name because they are localized maximum forces occurring prior to the bodies ability to actively respond to the landing through the neural-muscular system.

Force Reduction is presented as a percentage of the impact force generated on concrete. Force Reduction provides a strong indication as to the level of comfort the sports surface will provide users. The following equation is used to calculate force reduction*[1,2]*:

$$FR = 100 - \frac{F_{sportsurf}}{F_{concrete}}100$$

Where $F_{sportsurf}$ is the maximum impact force generated on the sports surface, $F_{concrete}$ is the maximum impact force generated on concrete and FR is the shock absorption of the system expressed in percent.

2.2. Vertical Deflection

Vertical deflection has a biomechanical basis. It is intended to ensure that the system provides shock absorption without 'bottoming out'. Bottoming out occurs when components of the system have been compressed to the point that their stiffness significantly increases. Higher vertical deflection values should help ensure that a floor has an adequate range of motion to provide shock absorbing properties to all athletes. The loading rate used during vertical deflection testing is more similar to those produced during running than during landing.

Vertical deflection, or deformation is a measure of how far the floor will deflect under an impact of 1500 N (335 lbs).Some sports surfaces 'bottom out' after very little motion but still provide shock absorption values that meet the standard.

Vertical deflection is expressed as millimeters of deflection, and is obtained from the following equation*[1,2]*:

$$StVv = \frac{F_{max}}{1500} \bullet f_{max}$$

Where F_{max} is the maximum force generated during the impact (N), f_{max} is the maximum deflection at the point of impact (mm), and StVv is the Standard Vertical Deflection (mm).

2.3. Friction / Slip Resistance

Friction is the resistance to slipping on the sports surface, and has biomechanical implications*[1,2]*. Friction that is too low will result in excessive sliding and make directional changes difficult. Friction that is too high or too low may increase the magnitudes of the forces and moments transferred through the joints in the body during directional changes thus increasing the possibility of injury. The DIN standard evaluates the friction using a weighted disk contacting the playing surface at three contact points covered with leather.

The slip resistance in DIN offers a relative comparison of friction properties between sports surfaces. It does not represent the absolute slip resistance present when modern athletic footwear is used. Representing the actual friction present in shoe-surface interfaces is not feasible given that the friction coefficient is effected by both tread geometry and tread material.

On wood sports surfaces, friction coefficient is usually affected only by wear layer, or by the layer actually contacted by the athlete. As an example friction properties are effected only by the polyurethane finish used to protect the wood. All wood systems coated with the same finish will have the same friction properties.

The friction property of a wood systems is dictated by the finish that is applied to the system. All wood systems using the same finish should have identical friction characteristics. There are a number of finish manufacturers, and each make products that range from traditional oil-based polyurethane finishes to more modern VOC compliant, or water-based polyurethane finishes. Some states mandate that only low VOC or water-based polyurethane finishes may be used, while others allow virtually all finish materials to be used. The result is that there is no one nationally standard urethane finish for wood sports surfaces. While friction is a biomechanical property, the variation of finishes available and mandated within the North American marketplace has caused ASET Services, Inc. to decide that it is inappropriate to include friction performance on general sports surface certificates.

3. DIN 18032 Part II and Safety

At this time no study or publication has been found that links a sports surface's compliance with this standard, or any other standard, to a reduction in injuries. There are no guarantees that a system meeting all of the requirements of the DIN standard will reduce injuries.

Specifiers should consider this standard an indicator of athlete comfort not an indicator of athlete safety.

This publication is provided by ASET Services, Inc. ASET Services is committed to providing engineering and testing services to the sports surfacing industry. For further information contact ASET Services through one of the following methods:

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4. References

1. (1998) DIN Standard 18032 Part II: Sports Halls, Halls for gymnastics, games and multi-purpose use. Part 2: Sports floors, requirements and testing.
2. (2001) DIN Pre-Standard 18032 Part II: Sports Halls, Halls for gymnastics, games and multi-purpose use. Part 2: Sports floors, requirements and testing.

