Courts & Recreation Safety Standards – What Contractors Need to Know

By: Paul Elliott, PhD, PE, CPSI
Introduction

• Dr Paul Elliott, PE, CPSI
  • Involved in sports surface testing and design since 1994
  • Member of ASTM F08 since 1997
  • ASET Services, Inc is a scientific body member of ISSS
  • Professional Engineering licenses in Ohio, and Indiana
  • CPSI certification since 2008
  • Worked as Research and Development Engineer for Robbins Sports Surfaces
  • Founded ASET Services, Inc in 2002
Introduction

• ASET Services, Inc
  • Provides lab and field testing of sports surfaces nationally and internationally
    • Indoor Courts (wood and synthetic)
    • Indoor and Outdoor Walk/Jog/Run Tracks
    • Synthetic Turf Fields
    • Playgrounds
    • Dance
  • Provides custom engineering and testing services
General Discussion on Safety

• Many in our industry throw around terms like ‘safe,’ ‘safer,’ ‘safety,’ when marketing and promoting products

• Here are some examples:
  • “…we can control the safety level of the playing surface”
  • “…delivers the performance and safety qualities athletes expect”
  • “…selecting a safe sports surface for your family”

• What do those words really mean?
General Discussion on Safety

• ISO 20183 contains Injury and Safety definitions and thresholds
  • Developed for Sports and recreational facilities

• Safe: state of being protected from recognized hazards that are likely to cause harm

• Safety: freedom from unacceptable risk, *but not safe*
  • Achieved by reducing risk to tolerable level
  • There is no complete absence of risk. Therefore there is no product that is without some risk
General Discussion on Safety

• Manufacturers, Installers, and Testing Houses should all evaluate their claims and language regarding safety
  • Are claims over stated?
  • What happens when an injury occurs on the ‘safe’ surface that was just installed?
Presentation Overview

The requested goal – To present safety standards that are relevant to the courts division of ASBA. This would include the entire range from basketball, volleyball, to pickle ball & variants.

• The standards might include those applying to the surface and the facility in general

• The scope was to be broad to include items from things like impact attenuation to runout and spacing standards between courts for various sports.
Presentation Overview

• Define the classes of standards
  • Safety
  • Playability
  • Technical

• Discuss safety standards
• Discuss playability standards
• Discuss technical standards
• Discuss published standards, guides or recommendations
Types of Standards

Definitions for this presentation

• Safety Standards—For this presentation this includes tests that are related to forces applied to or by the athlete during sports activities
  • Head Injury Prevention
  • Force Reduction
  • Vertical Deformation
  • Friction
Putting Safety in Context

• Head Injury Prevention – Not common yet in ‘courts’ division
  • Tests for Gmax and HIC have a scientific basis linking lower values of both to decreased injury rates and severity.

• For the other common ‘safety’ standards
  • There is not a study that links them to safety (ie reduced injury rate/severity)
  • Ex: Studies may link ‘hard surfaces’ to reduced shin splints but they don’t measure hardness using the standards the sports world uses
  • Unaware of a single study that shows that injuries are greater or lower based on a certain threshold for relating to any injury other than head injuries
Types of Standards

Definitions for this presentation

• Playability Standards – these properties effect how the game is played, and if it even can be played. May include
  • Ball Rebound (vertical – basketball)
  • Ball Rebound (angular – tennis)
Types of Standards

Definitions for this presentation

• Technical Standards – These properties define technical properties of the surface. They may include tests for durability or longevity. Examples include
  • Area Deflection
  • Tensile / Elongation
  • Rolling Load
  • Resistance to Abrasion (or wear)
Mandatory Safety Standards

• What are the mandatory safety standards?
  • Indoor Wood Courts – Basketball, Volleyball, Squash, Racquetball, Handball, Pickleball, Aerobics, Dance
  • Indoor/Outdoor Synthetic Courts – Basketball, Volleyball, Pickleball, Pickleball

• The answer is the same for all of them:
  • No standards are required for these surfaces in North America.
  • Owners and architects have the option of if, when and what to require
Safety Standards

• Gmax and HIC – Head Injury Prevention
  • Preventing head injuries is a growing concern within all sports
  • Gmax- represents the maximum impact force
  • HIC – is short for “Head Injury Criteria”
  • While the surfaces within the ‘ASBA-Courts’ division do not yet have requirements, elements within those spaces do
    • Wall padding
    • Wrestling mats
Safety Standards

• Gmax and HIC Existing Standards
  • Wall Padding – ASTM F2440
  • Wrestling Mats – ASTM F1018

• Items to consider
  • Basketball goal padding
  • Volleyball post padding

ASBA TECHNICAL MEETING & TRADE SHOW
NOVEMBER 30 - DECEMBER 4 | SCOTTSDALE, ARIZONA
Safety Standards

• Head Injuries
  • What you need to know:
    • Most rapidly expanding area with regard to new standard development
    • If you supply padding, consider asking your supplier if it has been tested to at least one of the head injury standards
    • Wall padding has an existing head injury standard but it may not be well known or widely used by architects yet
    • While not yet covered items like goal post padding represent a risk. Consider requiring it to meet F2440 for wall padding at a minimum.
Safety Standards

• Force Reduction (aka Shock Absorption)
  • What is Force Reduction?
    • It measures the ability of the surface to reduce impact forces to the foot, and is focused on the early portion of a landing (first 0.050 sec or less)
    • This test is one way of measuring the hardness of the sport surface
  • There actually is little to no data directly linking this property to safety.
  • There are however studies linking surface hardness to injuries such as shin splints
Safety Standards

• Force Reduction
  • A 20 kg mass impacts a 2,000 N/mm spring to generate an impact force.
  • The force reduction property is reported by presenting the magnitude by which the floor reduced the impact force on concrete as a percentage (ex. 55%)
Safety Standards

• Force Reduction
  • Indoor Courts – ASTM F2772, EN 14904, even DIN 18032-2, FIBA
  • Some outdoor courts may also provide this value: EN 14877
Safety Standards

• Force Reduction
  • What you need to know –
    • The equipment and methods are harmonized (all standards use the same)
    • There is no level that has been scientifically shown to be clearly unsafe, or to reduce fatalities.
    • Individual standards require different minimum allowed values
    • Performance levels are optional within North America
    • The owner and architect may arbitrarily set performance requirements for their individual installation
Safety Standards

• Vertical Deformation
  • There actually is little to no data **directly** linking this property to safety.
  • There is however unity within standards that excessive vertical deformation can cause instability of the foot, and excessive rotational friction
  • Measures how much the surface deflects under a standard load at the point of impact
  • Attempts to simulate the duration of an entire foot-surface contact during a running event
Safety Standards

• Vertical Deformation
  • A 20 kg mass impacts a 40 N/mm stiff spring to produce a deflection of the sport surface
  • Vertical deformation presents this deflection by normalizing the deflection to a 1500 N impact (ex 1.9 mm)
Safety Standards

• Vertical Deformation
  • Indoor Courts – ASTM F2772, EN 14904, even DIN 18032-2, FIBA
  • Some outdoor courts may also provide this value
    • EN 14877 Specific to Synthetic Outdoor Sports Areas
Safety Standards

• Vertical Deformation – Indoor Courts
  • What you need to know –
    • There is no level that has been shown to be clearly unsafe, or to reduce fatalities.
    • There are widely agreed to maximum values for vertical deformation on court surfaces
      • No surface greater than 5.0 mm
      • No synthetic component greater than 3.5 mm
    • Exceeding the 5.0 mm limit is thought to decrease to foot/shoe stability
    • Exceeding the 3.5 mm limit is thought to rotational friction by ‘foot blocking’
    • Performance levels are optional within North America
    • The owner and architect may arbitrarily set performance requirements for their individual installation
Safety Standards

• Vertical Deformation – Outdoor Courts
  • What you need to know –
    • There is no level that has been shown to be clearly unsafe, or to reduce fatalities.
    • Maximum allowed 3.5mm
    • Performance levels are optional within North America
    • The owner and architect may arbitrarily set performance requirements for their individual installation
Safety Standards

• Friction
  • There is little to no data showing that any standardized friction tests are related to an increase or reduction of sports injuries
  • There are numerous kinds of friction that occur
    • Static / Dynamic Friction, Linear Friction, Rotational Friction
  • Friction can be between multiple surfaces
    • Shoe/surface, Skin/surface
  • Friction Results Change When the load (weight) applied changes
  • Passing one friction test does not mean that the surface will pass another friction test
Safety Standards

• Friction – General Comment
  • Friction results depend on the type of friction (dynamic/static)
  • Results from one Friction test are often not correlated to another test.
  • One surface can have high skid friction, low static friction, and vice versa
Safety Standards

• Friction – Common Standards
  • Pendulum Test (ASTM F2772, EN 14904, FIBA)
    • Dynamic Skid Test using rubber contact foot
    • Modified rubber slider used to evaluate sport surfaces
  • James Machine - ASTM D2047
    • Nearly Static Test (3 in /min)
    • Uses A leather sole
    • Developed Polished Floors
    • Not developed with sports in mind
Safety Standards

• Friction
  • The pendulum is released from horizontal (right)
Safety Standards

• Friction
  • The pendulum is released from horizontal (right)
  • The strike foot skids along the surface
Safety Standards

• Friction
  • The pendulum is released from horizontal (right)
  • The strike foot skids along the surface
  • The indicator arm stops at the maximum height after the strike
Safety Standards

• Friction
  • The pendulum is released from horizontal (right)
  • The strike foot skids along the surface
  • The indicator arm stops at the maximum height after the strike
  • The indicator points to the scale on the left
Safety Standards

• Friction
  • I Personally Recommend Pendulum Method (ASTM F2772, EN 14904)
  • Indoor: ASTM F2772, EN 14904 and FIBA have same requirements
    • Avg between 80 and 110
    • No swing more than 4 from average
Safety Standards

• Friction
  • Outdoor EN 14877 requirements
    • Avg between 80 and 110 – Dry
    • Avg between 55 and 110 - wet
Safety Standards

• Friction
  • What you need to know:
    • There is no level that has been shown to be clearly safe/unsafe.
    • There are widely agreed to min/max values for friction levels of dry courts (80-110) using the pendulum test
      • Indoor courts are only tested dry
      • Outdoor courts may be tested wet and dry
    • While owners and architects can choose to specify friction, they should not specify ranges outside of standards
    • Dirt and dust, and residual cleaning compounds can greatly affect friction
Playability Standards

• Ball Rebound
  • Vertical Rebound – Basketball
  • No standards yet for pickle ball
• Indoor (EN 14904, ASTM F2772, DIN 18032-2) require >90%
• Some groups require (MFMA, FIBA) >93%
• Outdoor (EN14877) >85%
Playability Standards

• Area Deflection – ASTM F3248
  • Not clearly linked to injury prevention
  • A measure of strongly vibrations travel within a floor
  • May be considered safety standard by some
  • Case studies more strongly relate to comfort than safety
Technical Standards

• Indentation – EN 1516
• Impact – EN 1517
• Wear – ISO 5470
• Rolling Load – EN 1569
• Hardness – ASTM D2240
Technical Standards

• Tension & Elongation
• The most confusing standard in the market
• Tested using numerous standards
  • ASTM D412
  • ASTM D638
  • DIN 53455
Technical Standards

• Tensile and Elongation
  • Standards use different sample sizes and shapes, and different loading rates
  • Each standard produces results unique to it
    • Can not compare results from two different standards
    • Can not convert results from one standard to another
  • More important for outdoor surfaces with large temperature swings
  • My opinion- resistance to impact resistance is more important and is a better indicator of the strength of the system and probably sufficient for indoor surfaces
Basketball Run-Outs

• NBA & FIBA Require 8’ at the ends of the court (www.nba.com)
• NCAA establishes a restraining line 6’ from the baseline (www.ncaa.org)
• NFHS has no guidelines (www.nfhs.org)
Volleyball Run-Outs

- ASBA Courts Guide Contains Free Zone Information and Court Dimensions
  - NFHS – 6’ around court
  - International Volleyball – 6’ 6” around court
Pickleball (and Related) Free Zones

- Recreational Play (playing areas 30’ x 60’)
  - Recommended: 5’ beyond sidelines; 8’ beyond baseline
  - Preferred: 7’ beyond sidelines; 10’ beyond baseline
- Tournament and Championship Courts
  - 12’ beyond the sidelines, 15’ beyond baseline
- All referenced from ASBA’s Pickleball Courts Construction and Maintenance Manual
- With help from Alex Levitsky
Standards Related To ASBA Courts Division

• For future reference a list of common standards has been included
Standards Related To ASBA Courts Division

• ASTM - Specifications
  • F2772 – Indoor Courts
  • F2440 – Wall Padding
  • F1081 – Wrestling Mats

• ASTM – Methods
  • F2117 – Vertical Ball Rebound
  • F2659 – Force Reduction
  • F3248 – Vertical Deformation and Area Deflection

• ASTM Methods – Continued
  • E662 - Smoke Density
  • E648 – Critical Flux
  • E303 – Friction – Pendulum
  • D2047 – Friction / James Machine
  • ASTM F355 – Head Impact Attenuation
Standards Related To ASBA Courts Division

• ASTM – Methods
  • D412 – Tensile / Elongation
  • D638 – Tensile / Elongation
  • D2240 - Hardness
Standards Related To ASBA Courts Division

• EN Specifications
  • EN 14904 – Indoor Multi Use
  • EN 14877 – Outdoor Sports Areas

• EN Methods
  • EN 12235 – Vertical Ball Rebound
  • EN 13036 – Friction (Pendulum)
  • EN 1516 – Indentation
  • EN 1517 – Impact
  • EN 1569 – Rolling Load

• EN Methods
  • EN 14809 – Vert Def
  • EN 14808 - Force Reduction
  • EN 13645 – Specular Reflectance
Standards Related To ASBA Courts Division

• ISO Methods
  • ISO 5470 - Wear

• ASBA References
  • Pickleball – 2017
    • Suggested play zones / runouts
  • Indoor Sports – 2014
Safety Discussion

• What standards would you include in this discussion?
  • Why?

• What are you/ASBA doing about it?
  • Join ASTM? Be active voter? Attend Meetings? Help Draft Standards?
  • ASTM Soapbox
    • $75 – Individual Membership
      • Involvement/Voice in new standards
      • Free downloads from 1 volume
Contact

• Paul W Elliott, PhD, PE, CPSI –
  • Email: elliottp@asetservices.com
  • Phone: 812.528.2743

• ASET Services, Inc
  • www.asetservices.com

• Educational and Technical Documents can be found at:
  • www.asetservices.com/library/aset-publications
  • www.asetservices.com/blog