SUBJECT:

B A L L R E B O U N D

Reporters: Bernd and Jürgen Härting, IST

INSTITUT FÜR SPORTBODENTECHNIK

DIPL.-PHYS. B. HÄRTING VDI

S U M M A R Y

- Measurement procedure
- Measuring techniques
- Calculation of ball rebound
- Standards and Test specifications
- Descrepancies

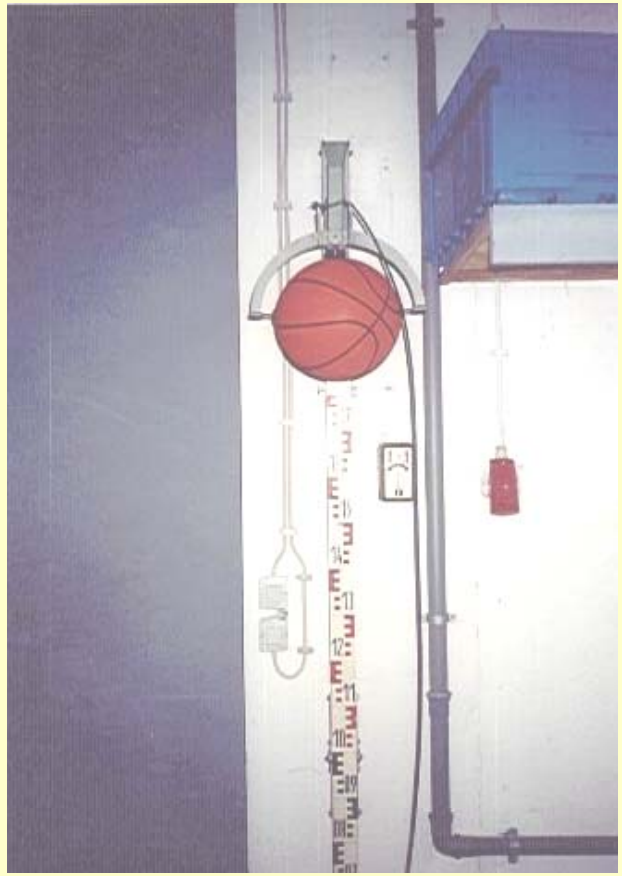
- Measurement procedure

  A ball is released from a given height (as determined by surface/ball type) and allowed to bounce on the sports surface. The height of the initial rebound from the surface is measured or calculated

- Test equipment
  - Ball as specified by the relevant sport body FIFA, FIBA, FIH, ITF ...
  - Ball release device (electro-magnetic for example)
  - Recording instrument

Measuring principles

- visual Measurement technique
  - vertical scale
  - video recorder or naked eye



Measuring principles

- acoustical Measurement technique
  - microphone
  - timing device

the timing begins with the first impact of the ball and is stopped at the second impact

INSTITUT FÜR SPORTBODENTECHNIK

DIPL.-PHYS. B. HÄRTING VDI

Measuring principles

- timing gate technique
  - infrared timing gate

the time begins as the rebounding ball moves past the lower timing gate and stops when it passes through the upper timing gate

UEFA: the timing gates shall be activated by the impact of the ball on the surface and not by the ball falling or rebounding

Calculation of ball rebound:

- acoustical technique (acc. to DIN EN 12235)

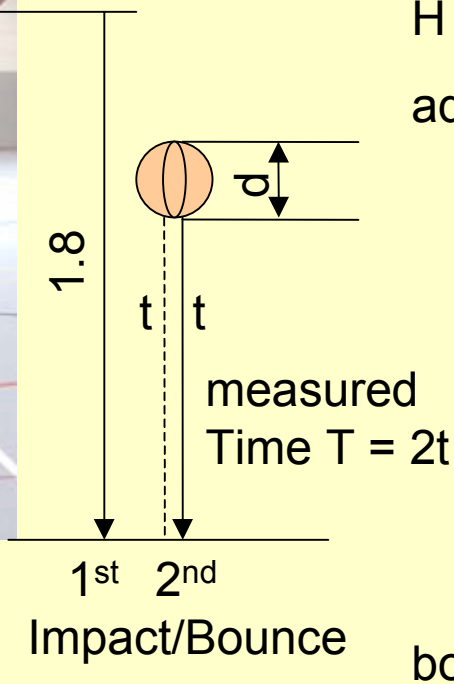
$$H = 1.23*(T-K)^2$$

H - ballrebound [m]

T - Time between first and second impact [s]

K - correction term [s]

critical Measurement point: bottom of the ball



based on the formula of free fall:

$s = g/2 * t^2$ with s = H, t = T/2, g = 9.81 m/s²

$H = 1.23 * T^2$ result in m for bottom of the ball

add the correction term K acc. to DIN EN

$$H = 1.23 * (T - K)^2$$

for top of the ball add d (diameter)

$$H = 1.23 * (T-K)^2 + d$$

calculation for required time:

bottom: $T = \sqrt{H/1.23}+K$ top: $T = \sqrt{H-d/1.23}+K$

INSTITUT FÜR SPORTBODENTECHNIK

DIPL.-PHYS. B. HÄRTING VDI

Standards and Test Specifications

DIN V 18032-2:2001-04 - Sports Hall Surfaces
DIN V 18035-7:2002-06 - Synthetic Surfaces
DIN EN 12235 - Vertical Ball Behaviour
ÖISS - Guideline Sports Hall Surfaces
FIFA - Quality concept Artificial Turf
UEFA - Artificial Turf in UEFA Competitions Part 2
FIBA - Equipment rules
ITF - Approved Tennis Balls & classified court surfaces
FIH - Synthetic Hockey Pitches-Handbook of Requirements
IHF - Guidelines for the Construction of Handball Playing Halls
BS 7044 Section 2.1 - Artificial Sports Surfaces
ASTM F 2117-01-Standard Test Methods for Ball Rebound
ISA F7-

Basketball				
	DIN EN 12235	DIN V 18032-2	ÖISS	FIBA IHF
Drop Height [m] (bottom)	1.80	1.80	1.80	1.80
Critical Measurement Point	bottom of ball	top of ball	bottom of ball	top of ball
correction [s]	0.025	not specified (usual practice:0.025)		
requirement [%] sports surface	none	min.90	min.90	min.90
requirement [m] rigid surface	1.30	1.30	1.30	1.30

Football (Soccer)				
	DIN EN 12235	DIN V 18035-7	UEFA	FIFA
Drop Height [m] (bottom)	2.00	1.80	2.00	2.00
Critical Measurement Point	bottom of ball	bottom of ball	bottom of ball	bottom of ball
correction [s]	--	not spec.	0.025	--
requirement sports surface	none	max.90%	0.6-0.85 m	30-50% related to drop height
requirement [m] rigid surface	1.35	1.20-1.40	1.35	1.35

INSTITUT FÜR SPORTBODENTECHNIK

DIPL.-PHYS. B. HÄRTING VDI

Tennis ball			
	DIN EN 12235	DIN V 18035-7	ITF
Drop Height [m] (bottom)	2.54	1.80	2.54
Critical Measurement Point	bottom of ball	bottom of ball	bottom of ball
correction [s]	0.005	not specified (u.p.:0.005)	0.005
requirement sports surface	none	min.80%	80-100%
requirement [m] rigid surface	1.40	1.35-1.47	1.35-1.47

Hockey ball			
	DIN EN 12235	DIN V 18035-7	FIH
Drop Height [m] (bottom)	2.00	1.50	1.50
Critical Measurement Point	bottom of ball	bottom of ball	bottom of ball
correction [s]	--	not specified (u.p.:--)	--
requirement [cm] sports surface	none	12-40	10-40
requirement [cm] rigid surface	57.5	not spec.	not spec.

Discrepancies:

1. Basketball
   - using top of the ball for the calculation of ball rebound means:

     $H = 1.23(T-K)^2+d$ d = diameter of the ball

     if T = 0 (ball sitting on the surface!) then H = d!!

   - time difference between top and bottom:
     result for H = 1.3 m (required ball rebound on concrete)

     T_{top}= 949 ms but **T_{bottom} = 1054 ms**

Discrepancies:

2. Football (Soccer)

- UEFA
is using a correction term with $\Delta t = 0.025$ s

but
acc. to DIN EN 12235 (used also by FIFA) there is **no correction term** for football (soccer)

usual practice is different

What is the correct way ??

Influence of correction term for football (soccer)

$$H = 1.23 * (T - K)^2$$

Measured Times: T_{RS} = 1.060 s, T_{AT1} = 0.950 s, T_{AT2} = 0.760 s

RS = rigid surface

AT = artificial turf

UEFA (with K = 0.025 s)		DIN EN 12235 (without K)	
H_{RS} = 1.32 m	H_{AT1} = 1.05 m H_{AT2} = 0.66 m	H_{RS} = 1.38 m	H_{AT1} = 1.11 m H_{AT2} = 0.71 m
BR1 = 79.9 % BR2 = 50.4 %		BR1 = 80.3 % BR2 = 51.4 %	

The examples show that the differences of the ball rebound are not more than 1% in the area between 50% to 80% !!

INSTITUT FÜR SPORTBODENTECHNIK

DIPL.-PHYS. B. HÄRTING VDI