INTERNATIONAL ASSOCIATION FOR
SPORTS SURFACE SCIENCES

ISSS Technical Conference Shanghai 2012

Advanced Artificial Athlete AAA

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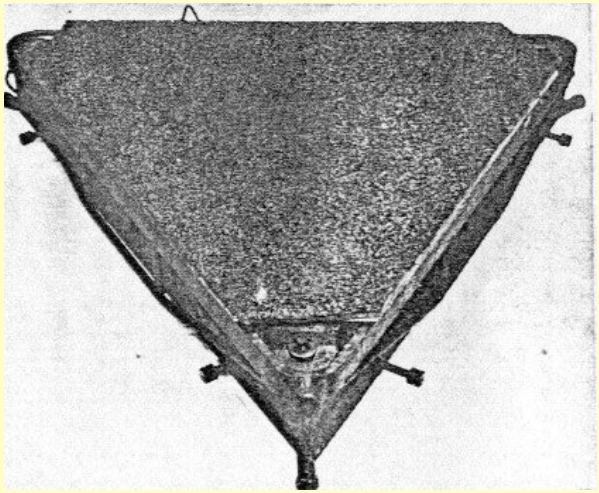
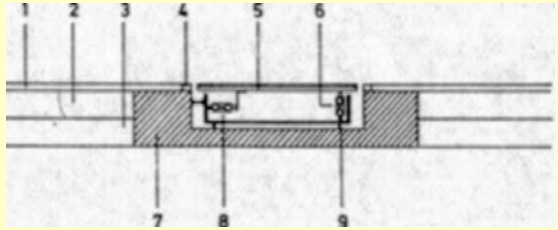
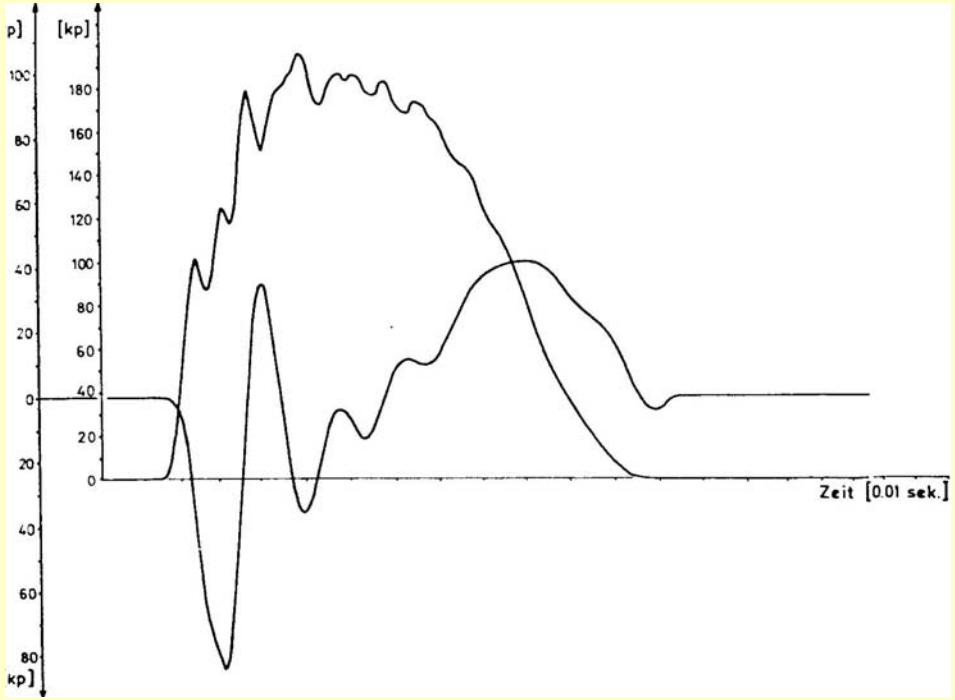
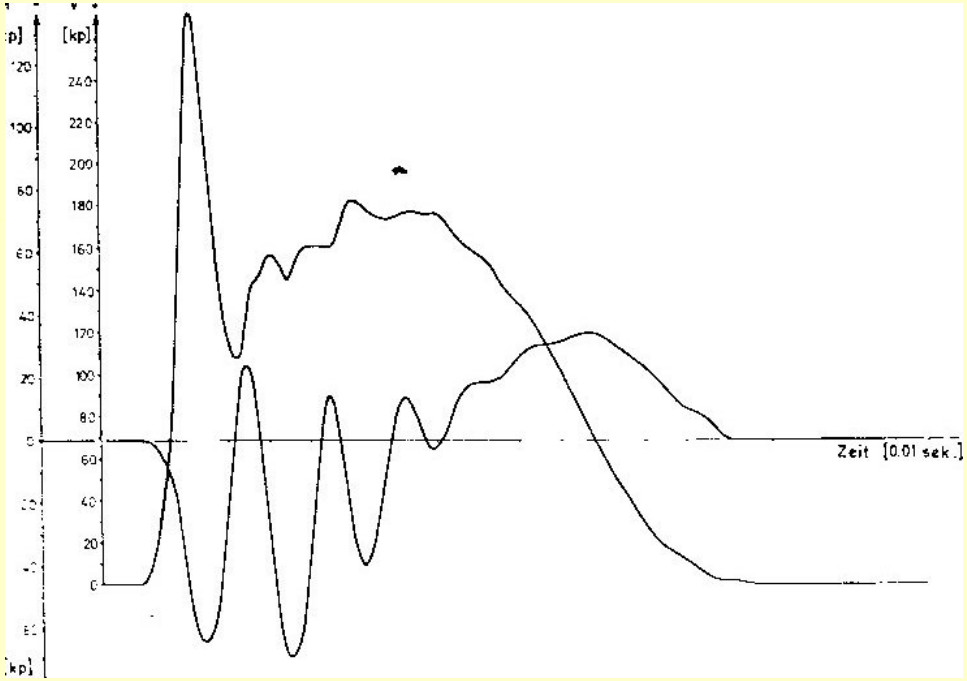
Biomechanical Balance/Platform 1968





Force-Time Traces of Biomech. Platform





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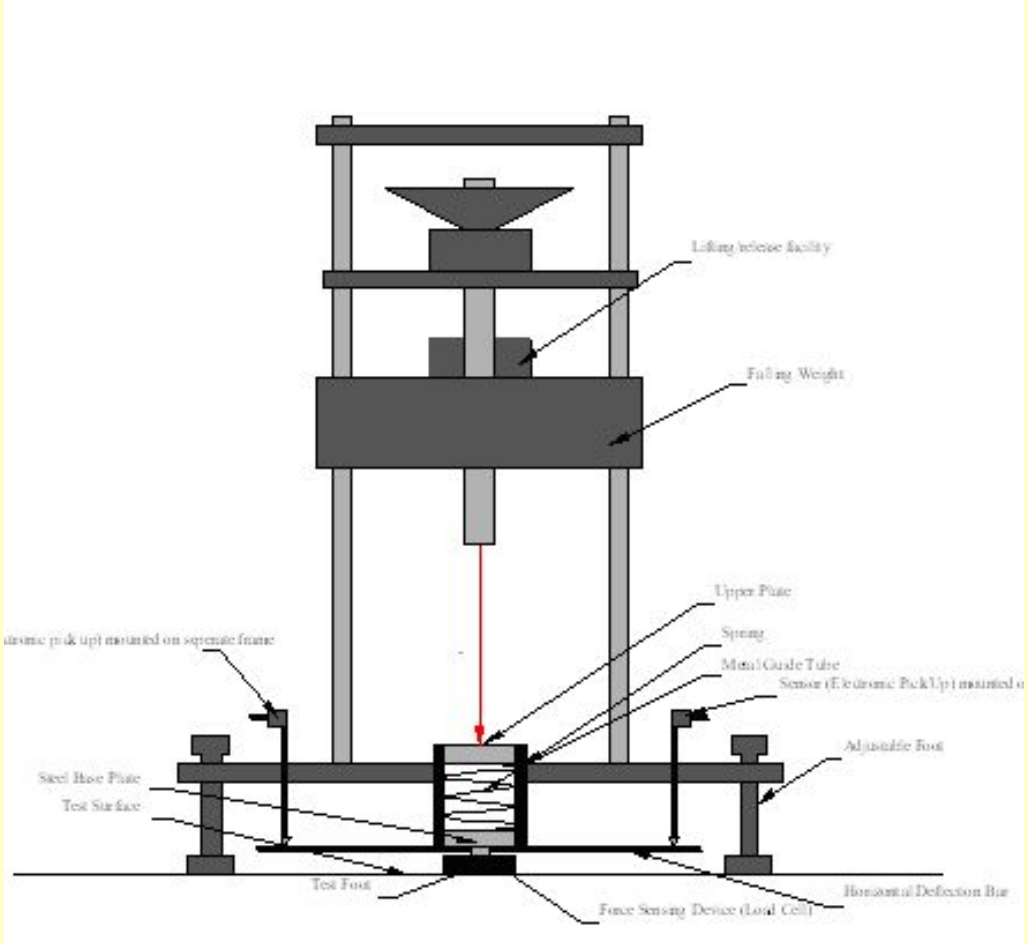

Artificial Athlete Stuttgart EN 14809

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Artificial Athlete Stuttgart

1968 - 1975

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Stuttgart Artificial Athlete

Test procedure:

- Undertake three tests at 1 minute intervals
- Determine maximum deformation under standard load of 1500 N for each test using:

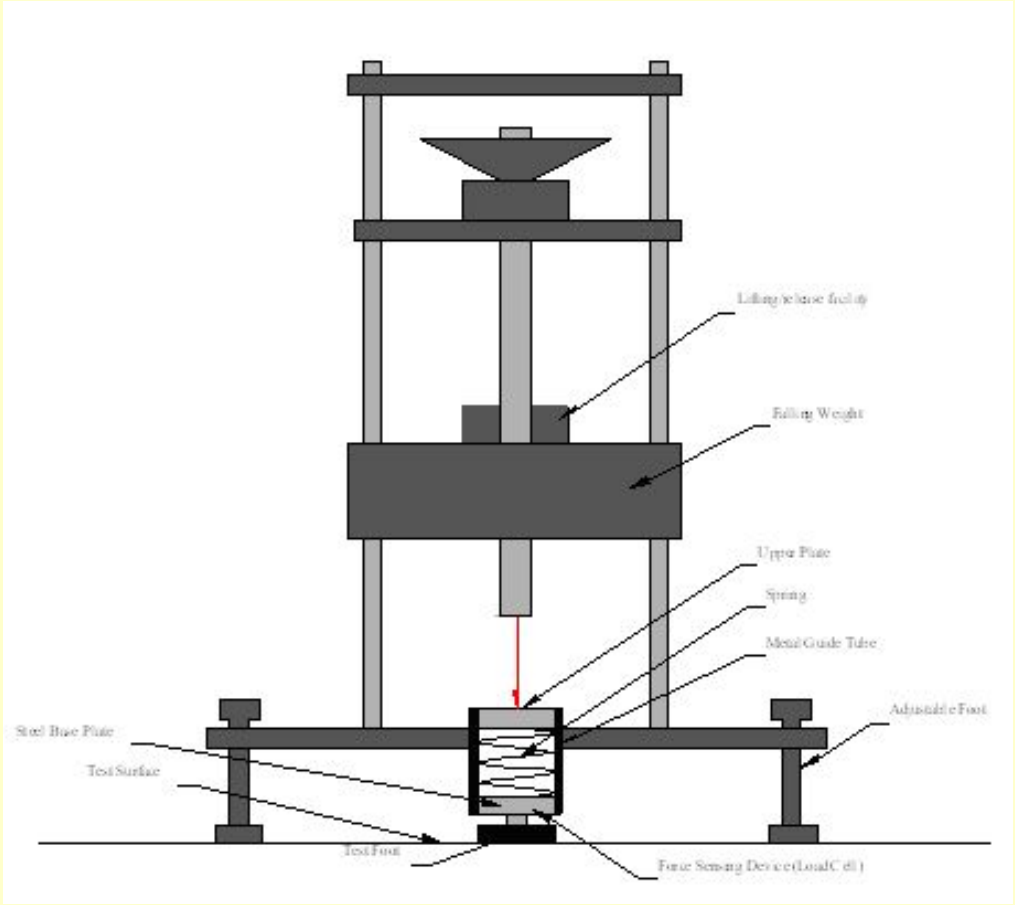
$$VD = \left(\frac{1\,500}{F_{max}} \right) \cdot d_{max}$$

VD = vertical deformation

F_{max} = max. force

d_{max} = max. deformation

- Calculate mean result of 2 & 3 impacts



Artificial Athlete

Berlin EN 14808

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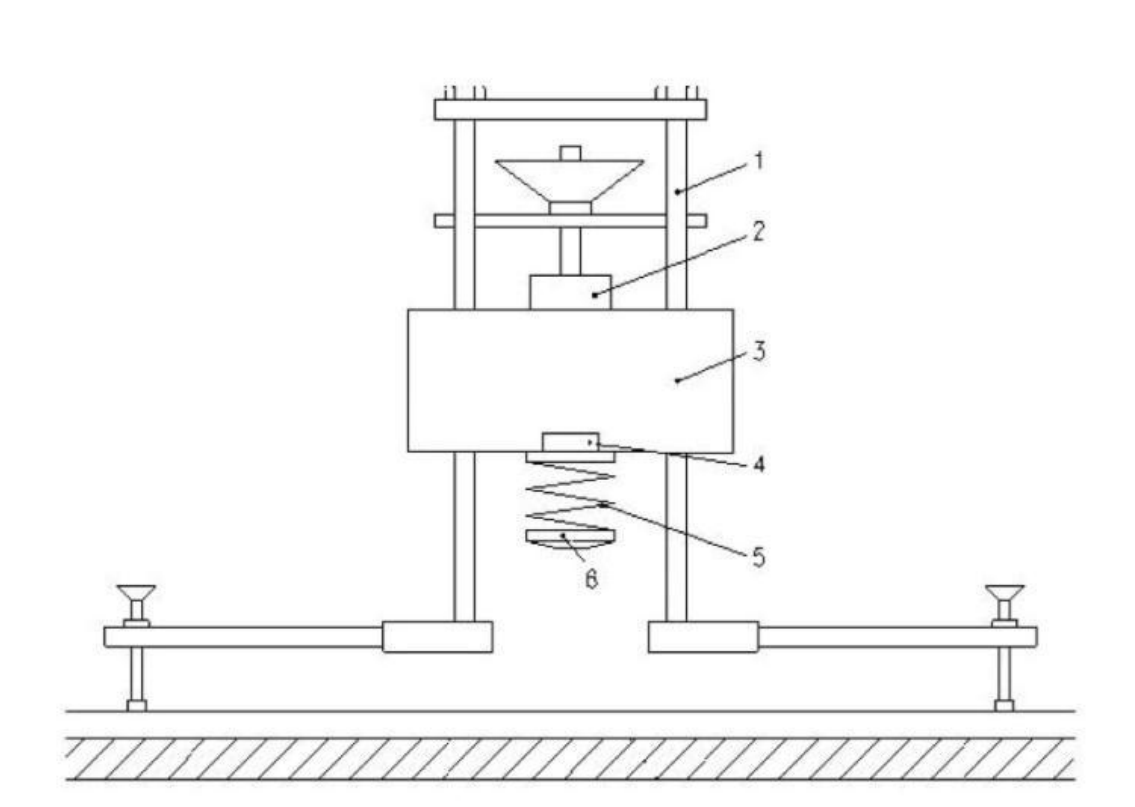
Berlin Artificial Athlete: Test procedure:

- Determine peak force on concrete (6.60 +0.25kN)
- Determine peak force on sports surface –
  mean of impacts 2 & 3 on same position
- Calculate Force Reduction using:
  $FR = 100 \times (1 - F_{max(testpiece)}/F_{max(concrete)})$ in [%]

Advanced Artificial Athlete AAA



1. Support frame and guide
2. Magnet
3. Falling weight
4. Accelerometer
5. Spring
6. Test foot

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Advanced Artificial Athlete (AAA)
FIFA + prEN

- Determination of 3 parameters with 1 impact
- Easier calibration through use of accelerometer
- More areas on a field accessible in given time
- More consistent information about whole field
- Reduced weight to aid equipment transportation
- Possibility to measure Energy Restitution

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Advanced Artificial Athlete (AAA)

Force Reduction(AAA) **=** Force Reduction(AA)

Vertical Deformation(AAA) ≠ VD(AA)

- impact force(AAA) >> 1500N
- impact time(AAA) << impact time(AA)
  since spring numbers different
- determination by double integration of
  deceleration–time–trace

Energy Restitution = new

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Advanced Artificial Athlete (AAA)
Calculation of shock absorption

$$F_{max} = m \times G_{max} \times g + m \times g$$

- Fmax is the calculated peak force for the test specimen expressed in Newtons (N);
- Gmax is the peak acceleration during the impact, expressed in g's (1 g = 9.81 m/s²)
- m is the falling weight including spring, test foot, acceleration sensing device expressed in kg, (20 kg).
- g is the acceleration by gravity (= 9.81 m/s²).

Advanced Artificial Athlete (AAA)
Calculation of energy restitution

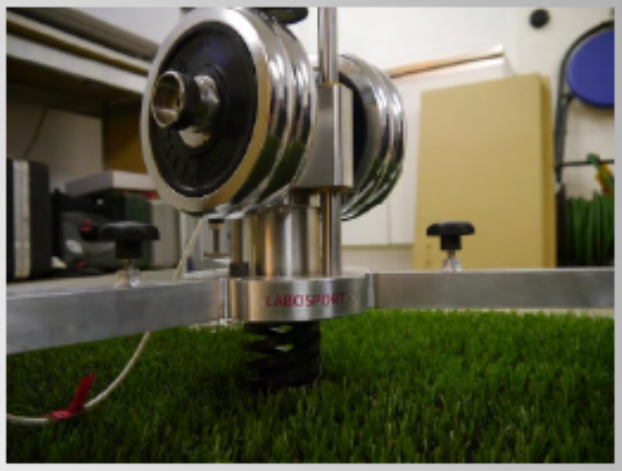
Energy restitution ER (%) defined by:

$$ER = E_2/E_1 * 100$$

E_1 is the energy before impact.
E_2 is the energy after impact;

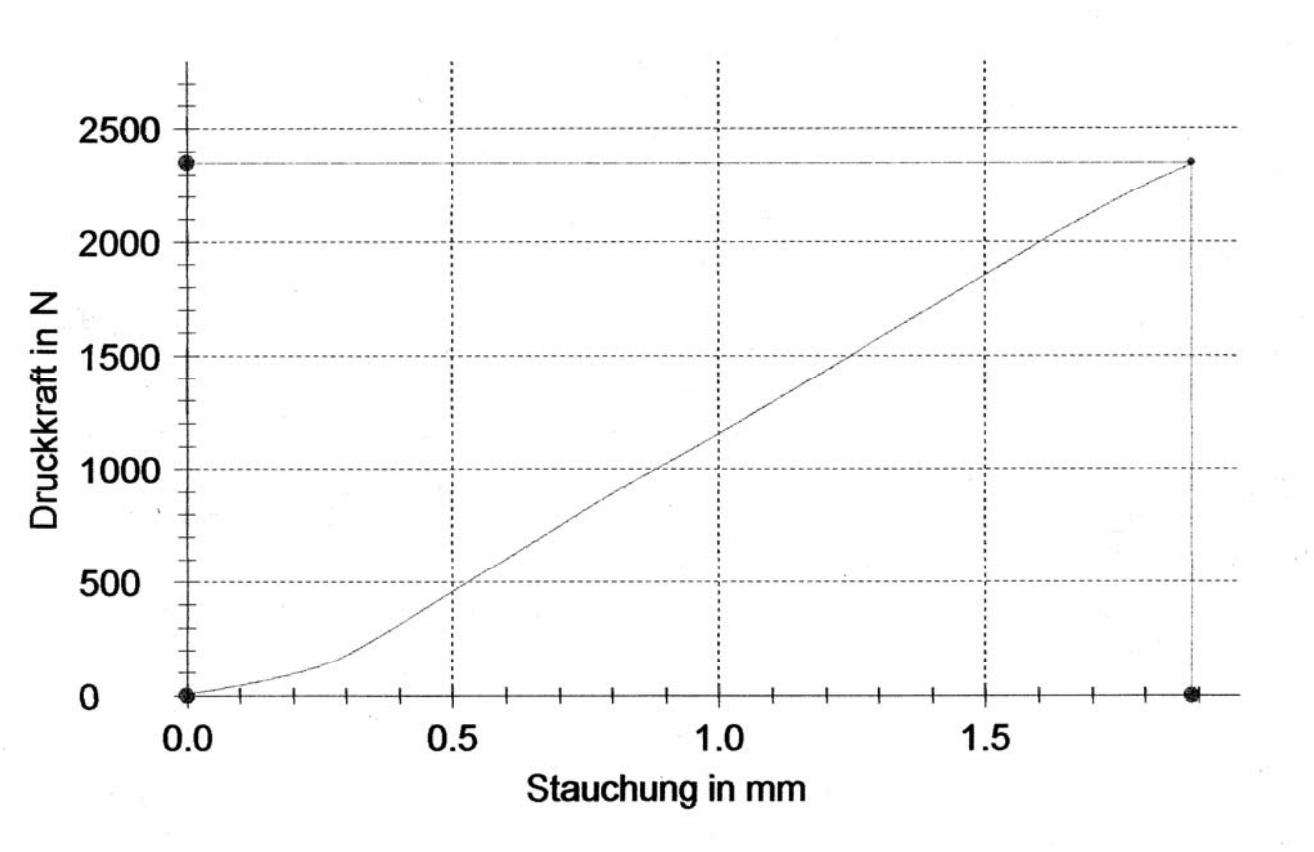
$E_1 = ½ m V_1^2$
$E_2 = ½ m V_2^2$

V_2 is the take-off velocity [m/s]
V_1 is the initial impact velocity [m/s]
M is the mass [kg]

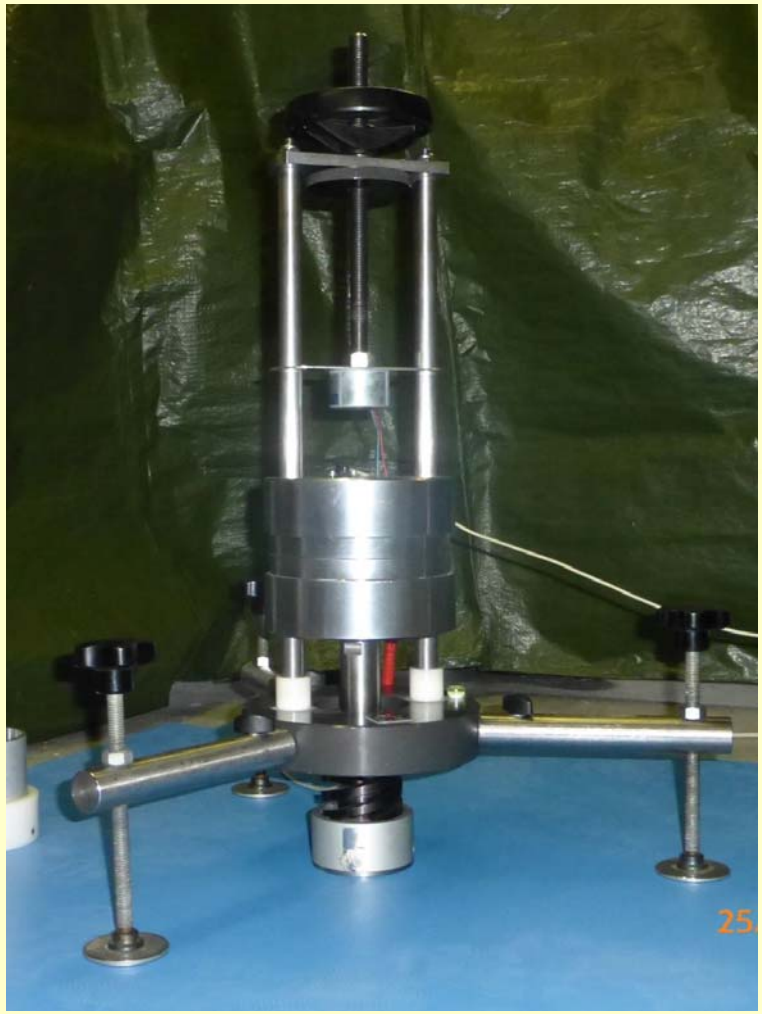


Reference Norm

Reference Norm



Characteristics:
- deformation linear
- no damping
- constant over time



Advanced Artificial Athlete AAA

on Reference Norm

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Results AAA on Concrete

FR(AAA) = 0 %

VD(AAA) = 0.29 mm

VD(AAA_{1500}) = 0.06 mm

ER = about 95 %

Results AA + AAA on Reference Norm

FR(AAA) = 38.1 % **FR(AA) = 39.0 %**

VD(AAA) = 3.28 mm **VD(AAA_{1500}) = 1.18 mm**

VD(AA) = 1.29 mm

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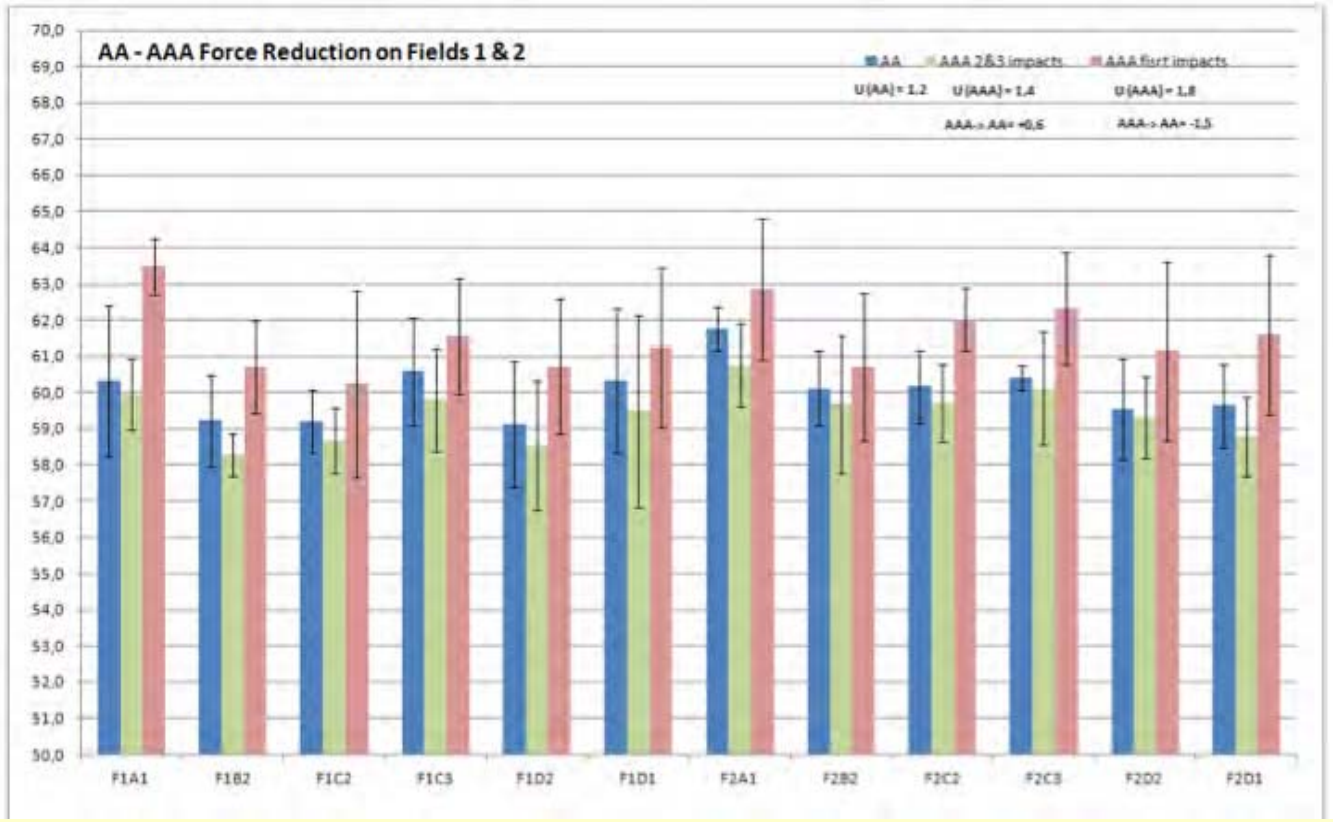
Results for Reduction of Force

On fields...



Correlation Study

Louveau + Harrison

blue =FR(AA)

green = FR(AAA) 2.&3. impact

red = FR(AAA) 1st impact

FR(AAA)=FR(AA)-0.6

FR(AAA)=FR(AA)+1.5

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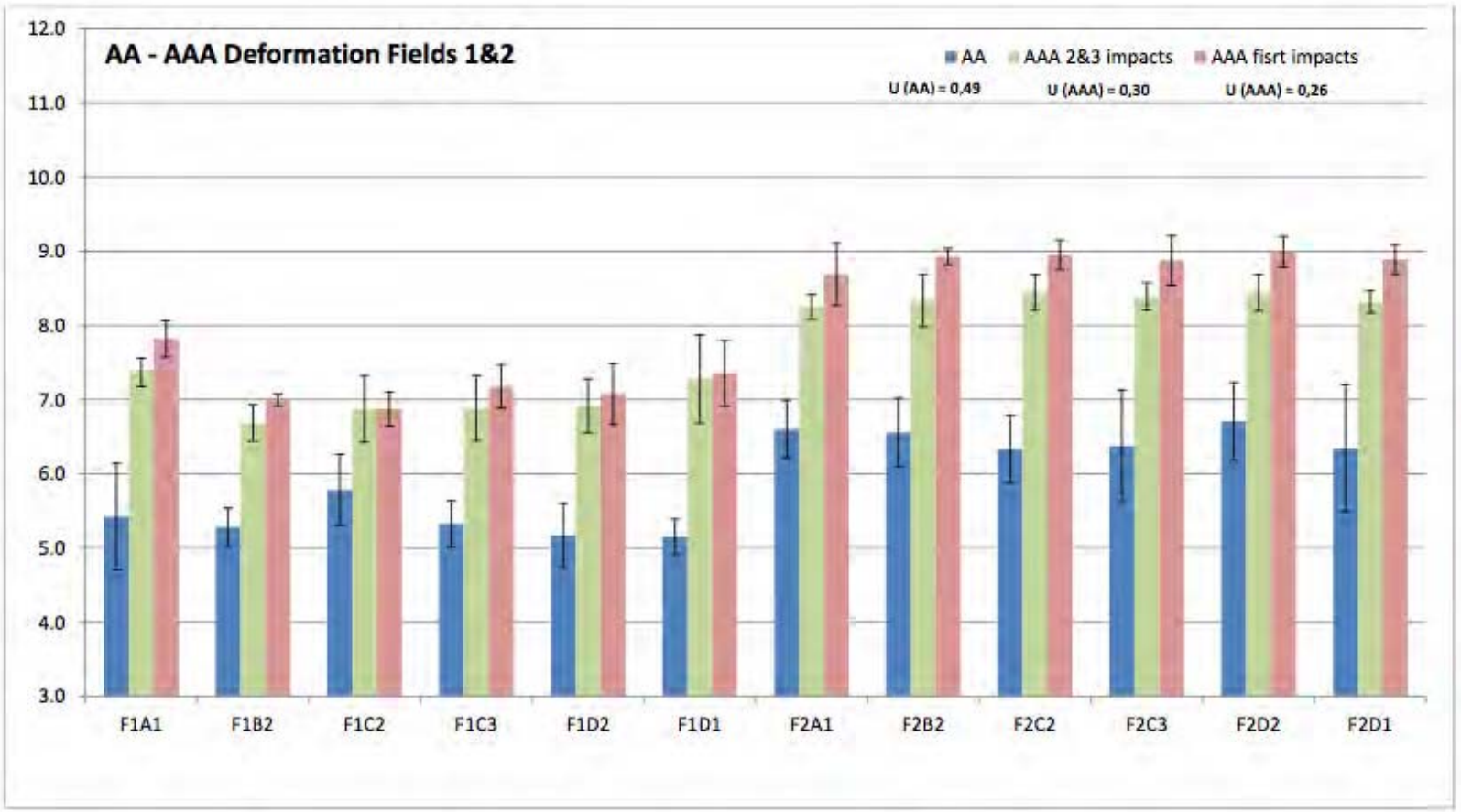
On fields



Correlation Study

Louveau + Harrison

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Results FIFA Study

Arnoud Louveau + Eric Harrison

Artificial Turf (2 pitches)

FR(AAA) ~ FR(AA) – 0.6 [%] 2.&3. impact

FR(AAA) ~ FR(AA) + 1.5 [%] 1. impact

VD(AAA) ~ VD(AA) + 1.6 [mm]

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Results FIFA Study
Arnoud Louveau + Eric Harrison

Energy Restitution ER

Natural Turf 20 – 40 [%] in summer

Artificial Turf 35 – 45 [%]

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