Instituut voor Sportaccommodaties

Triple A

An update

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October 21nd 2010

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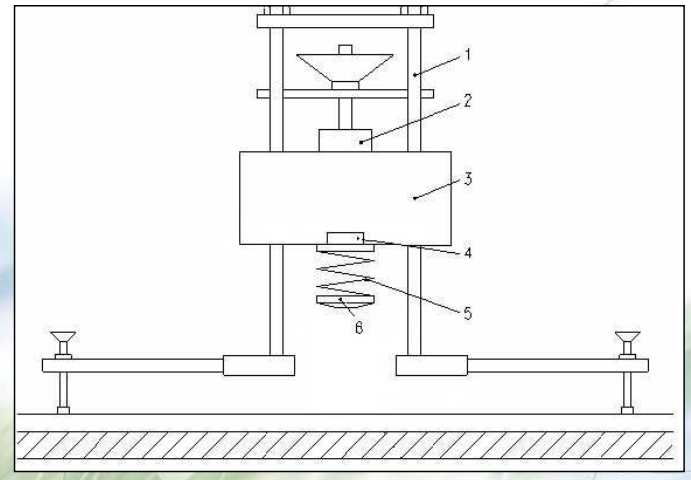
Advanced Artificial Athlete detail (Triple A)

Triple A



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Determination of F_{ref}

- Spring mass 0.8 kg and mass footplate .4 kg total 1.2 kg
- Mass total drops 55 mm
- Mass without spring and footplate drops the impression of the spring (x)
- The center of gravity of spring moves 0.5 x downwards
- The footplate does not move further, stays at 55 mm
- At maximum impression all velocities are zero, all energy in spring (1/2 . C . x^2)
- energy is what all masses have moved down (loss in potential energy)

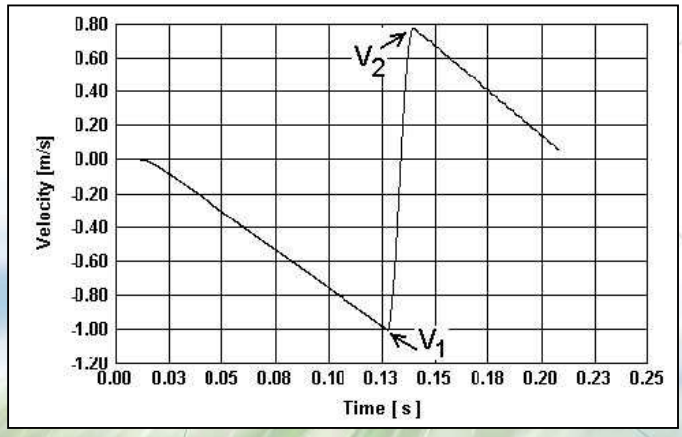
Force calculations

- F_{ref} in formula:

  $0{,}5\ c.u^2-(m-0{,}5m_s-m_f).g.u - m.g.h = 0$
- Resulting in F_{max} = 6760 N
- U = 3,4 mm (max. spring deformation)

- $F_{max} = m * G_{max} * g + m * g$

Speed calculations



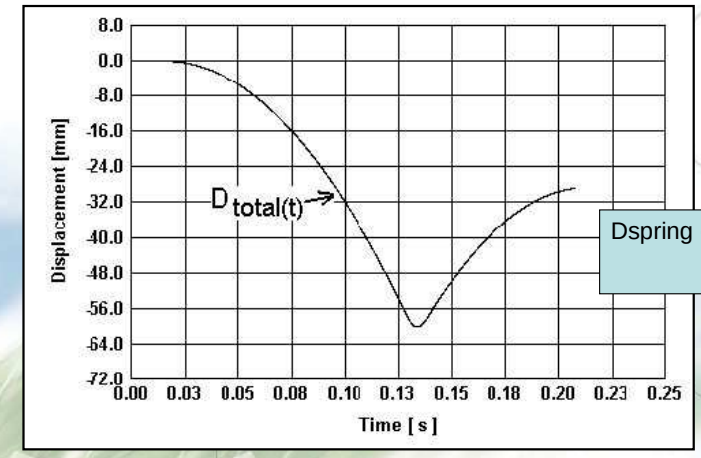
$$ER = \frac{E_2}{E_1}.100\%$$

$E_1 = ½\ m\ V_1^2$
$E_2 = ½\ m\ V_2^2$

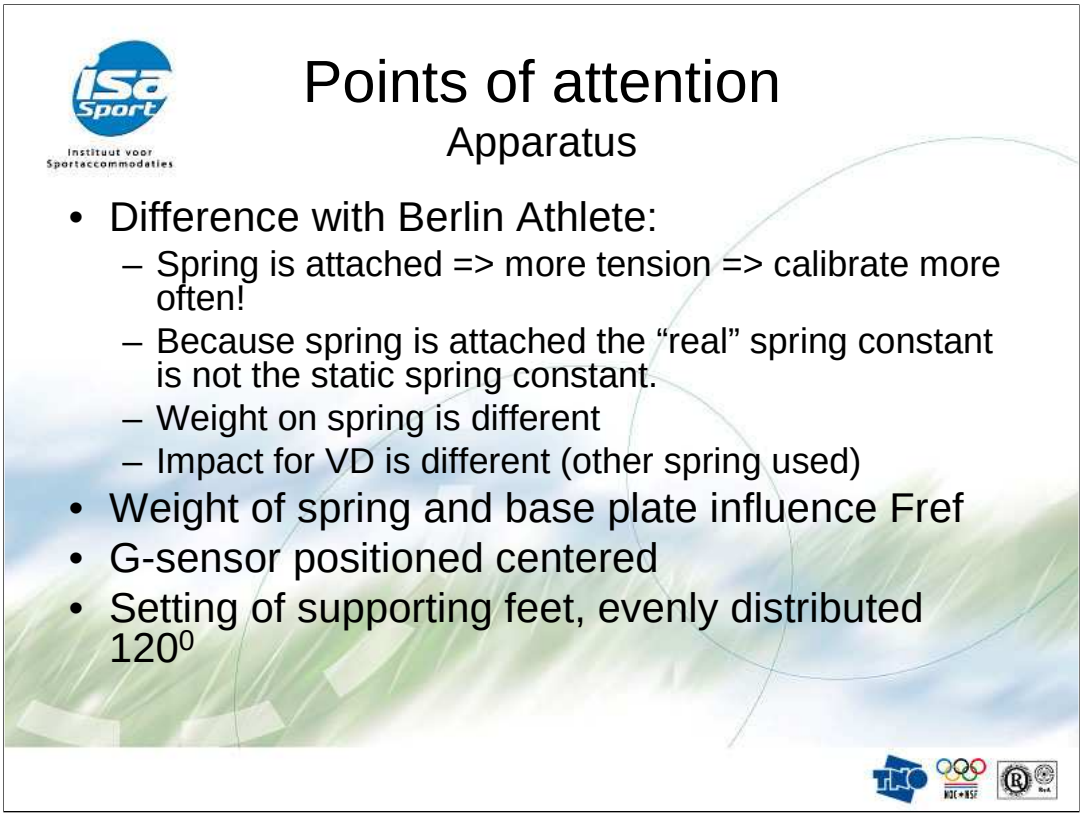
Note: ER of complete system

Deformation

VD = max [D_{weight} (t) - D_{spring} (t)]$_{max}$ on the interval [t1,t2]



Dspring (t) = Fspring (t) / Cspring
= m * G(t) * g / Cspring



The spring is attached to the falling weight. This means that it does not have the possibility to rotate during impact. This causes much more vibrations in the spring and the spring deteriorates faster. On a Berlin Athlete the spring is standing alone and has the possibility to rotate during impact.

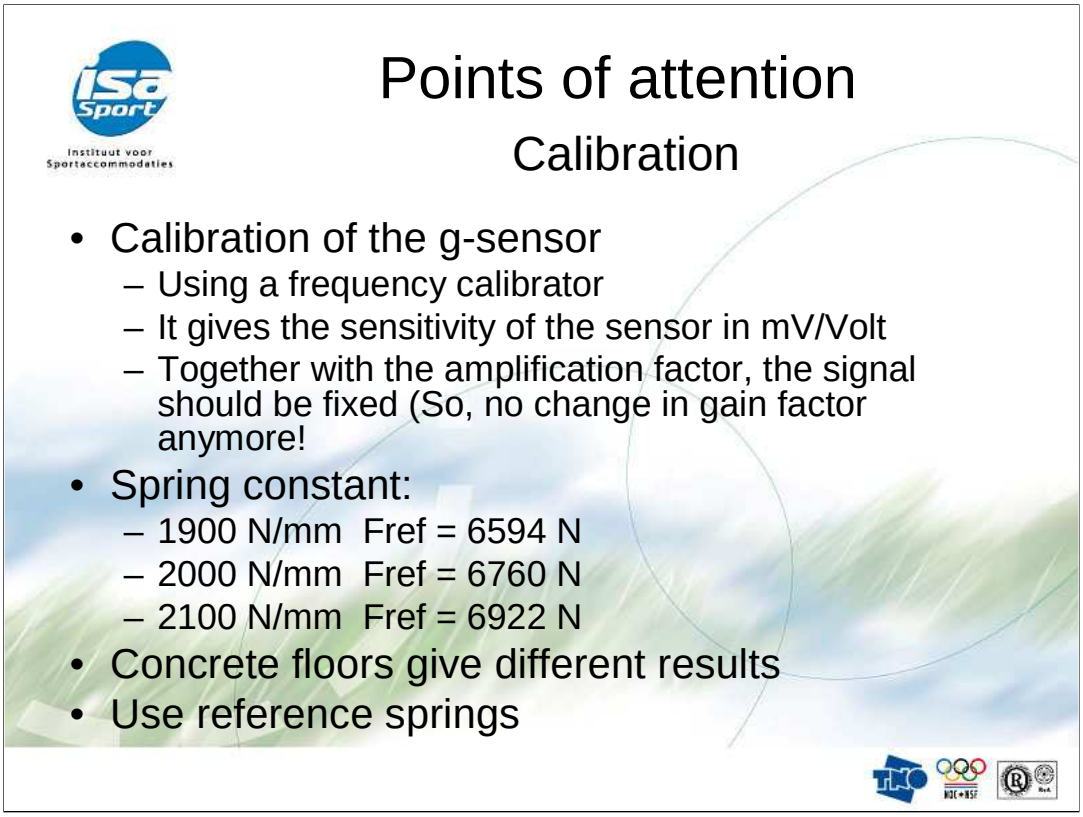
As the calibration is done with the spring able to rotate and the measurement is done with the spring not able to rotate, the spring behaves differently during the impact.

For the Triple A it counts that the weight on the spring is different from the weight falling on the spring of the Berlin Athlete; in the Triple A the total weight is 20 kg, including spring and base plate. When the base plate weights 400 gr and the spring 800 gr and the point of gravity is taken as point of impact, the total weight on the spring is 20 kg – 400 gr – 800/2 gr. If you look at the calculation on one of the former slides, you can see in the formula that the weight of spring and base plate influence the Reference Force.

The vertical deformation of Triple A and Stuttgart setting of the Artificial Athelte are not comparable, not only becauses of the usage of deformation transducers but also because of the use of a spring with another spring rate.

The G-sensor should be positioned as much as possible to the center of gravity of the falling weight. The weight will never fall exactly vertical, so with the sensor centrally positioned the unwanted side effect is reduced as much as possible

The supporting feet should be evenly distributed as much as possible. The measurement takes the bending of the feet into account, while the weight is hanging in the apparatus. As soon as the weight is released, the apparatus lifts up a little because the weight on the feet is lowered. If the feet are not evenly distributed, the lift of the feet differs, because the weight on the feet is not equal. This might cause the weight to fall not exactly vertical.



The calibration of the sensor can be done with a frequency calibrator. This is a small device giving a frequency and measuring the sensitivity of the G-sensor in mV/Volt. In the past, the Triple A was verified on concrete to meet the required velocity and deformation. If the values were not correct, an amplification factor was used to meet the right values. We think this is not the right way. When the Triple A is calibrated correctly, an additional amplification factor is not needed. Additionally, the force on concrete can also be verified, which should be within a range of e.g. 6760 +/- 200 N. This reference force should be used for the calculation of the shock absorption (just like the Artificial Athlete).

Not every concrete floor gives equal results.

For calibration it is also very handy to use reference springs, on which the expected force is known.

These points give a next step forward on accuracy of this apparatus

Points of attention
procedure

Procedure:

- Calibrating on F_{ref} is possible (+/- 200 N)
- Use F_{ref} in the calculation
- Relaxation of material 30 seconds
- Improvement (?): use a surface plate, but that would change the results totally.

Triple A acceptance

- Round Robin test nov 2009 FIFA labs Valencia:

FR (%)	S1	S2	S3	S4
lab 1	49,2	60,4	61,5	30,4
lab 2	46,2	58,9	60,7	26,4
lab 3	49,4	59,6	59,3	29,3
lab 4	49,3	60,6	62,1	28,1
lab 5	47,9	59,5	61,4	27,8
lab 6	49,1	60,4	62,8	31,6
Average	48,5	59,9	61,3	28,9
Sdev	1,2	0,7	1,2	1,9
Sdev %	2,6	1,1	2,0	6,5

Field RRT

	lab 1			lab 2			lab 3			lab 4			lab 5		
	FR	ER	VD	FR	ER	VD	FR	ER	VD	FR	ER	VD	FR	ER	VD
AVG	51,5	44,4	6,6	51,3	42,6	6,6	50,7	45,0	6,4	51,4	41,9	6,4	51,0	44,2	6,8
STD	3,2	2,3	0,5	3,2	3,3	0,6	4,8	3,2	0,8	4,4	3,0	0,8	2,8	2,8	0,7

	lab 1			lab 2			lab 3			lab 4			lab 5		
	FR	ER	VD	FR	ER	VD	FR	ER	VD	FR	ER	VD	FR	ER	VD
AVG	51,5	44,4	6,6	51,3	42,6	6,6	50,7	45,0	6,4	51,4	41,9	6,4	51,0	44,2	6,8
STD	3,2	2,3	0,5	3,2	3,3	0,6	4,8	3,2	0,8	4,4	3,0	0,8	2,8	2,8	0,7

Field RRT

Field 1

Gobal Average		
FR	ER	VD
51,2	43,6	6,6
0,3	1,3	0,2
0,3	1,2	0,2

Field 2

Gobal Average		
FR	ER	VD
55,0	39,4	7,2
0,9	2,9	0,1
0,8	2,6	0,1

Acceptance of Triple A

Used since 2007 in the Netherlands for football, hockey and tennis.

Proposed for FIFA

- Triple A proposed for new manual (2011) for SA and VD
- Shock absorption equal standards (“softer”)
- Vertical Deformation adjusted (higher impact), deformation plus 2 mm.
- Uniformity requirement (deviation from average)
- Energy Restitution depending on biomechanic research

CEN

- Draft proposed to WG11 in September 2010. RRT takes place next meeting in Arnhem

The End

Questions?