# MEASUREMENT OF AMORTISATION AND TAKE - OFF FORCE IMPULSE DURING THE JUMP WITH BOTH LEGS

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## INTRODUCTION

The various forms of jumps belong to frequently used training methods (Simonek 1994). They are used to test and determine the state of training level. It is also convenient for training process management (Fohrenbach 1991). Frick (1991) was busy about measure procedures of determining the height of the jump and their comparison. Using simple equipment (the contact board) it is possible to gain the parameters of maximal alactat performance of lower extremities (Hamar 1989). Squat jumps and countermovement jumps allowed to find out the parameters of slow muscle work (stretch - shortening cycle). Drop jump can help us to find out the parameters of fast stretch - shoterning cycle. There exists an optimal height of drop jump in which optimal using of amortisation impulse can be reached. The height of the jump is characterized by the difference between the vertical coordinate of the highest point of trajectory of gravity centre and between vertical coordinate of gravity centre in quiet standing. So the part of the height of the jump is the lift of the body on the tiptoes just before the end of the take - off phase of the jump. The testing person is also landing on tiptoes. The fast movement of upper extremities also influences the movement of the overall gravity centre of body during the take - off phase. These facts have been taken into the consideration in calculating the amortisation of take - off impulse. Using of movement analysis in space with high frequency film records. which demands time and equipement is not necessary when using suggested procedure.

## TEORETICAL BASE

The total force impuls Itot is evaluated as sum of amortisation impulse la and take - off impulse It from the course of signal which is given by dynamometric board.

$$I_{tot} = I_a + I_t \quad (1)$$

The height of the jump can by calculated from the take - off impulse in formula

$$h_t = I_t^2/(2.m^2.g) \quad (2)$$

Applied formula for height of the jump calculated from the flying phase

$$h_f = (1/8).g.t_f^2 \quad (3)$$

At assumption

$$h_f = h_t \quad (4)$$

we can substitute for height of the jump from formula (3) into the formula (2) and we gain relation for the take - off impulse

$$I_t = (1/2).g.t_f.m \quad (5)$$

Applying formula (5) to (1) we gain for amortisation impulse

$$I_a = I_{tot} - I_t \quad (6)$$

The assumption expressed in formula (4) is not fulfiled. During the finishing phase of take - off lifting of gravity centre to the tiptoes appears. The finishing phase of take - off is superposition of lift of fhe body to the tiptoes and of extension of knee and joints. In principal, the influence of these three movements can not be detected from the force course. To do this a kinemagrafic analysis of video-records would be necessary to be used. This is a method which is not able to gain information without time.

## METHOD

The problems **connected** with gaining of the **flying** phase when force level is zero and difficulties connected with the fulfilling of the formula 4 will be compensated by correction of the flying phase duration. The jump height **concerning** the **lift** of the centre of gravity up to the legs tips will be higher then the jump height calculated from the flying phase duration gained when the force level is zero. So we shall **reach** for such a force level to find out the flying phase duration, in the purpose to fulfil the formula 4.

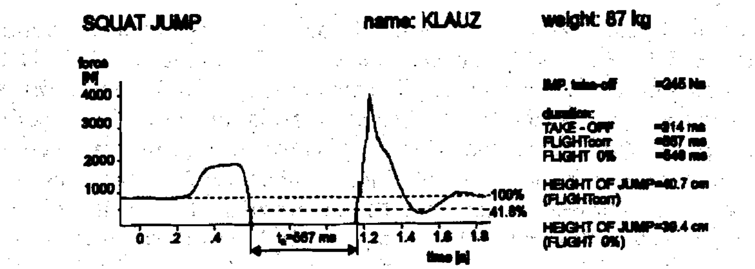



**Fig. 1**

The figure No. 1 shows the course of vertical force in the squat jump. There is a rule, in a squat jump, that the total impulse is the same as the take - off impulse. The amortisation impulse equals zero. At this type of jump gravity force is the same as the force before the take - off phase. This condition was strictly held by the jump analysis. The influence of the upper extremities was eliminated by fixing. The gravity force was base of discovering duration of the flying phase. This value represents 100 percent. **The** duration of the flying phase was represented at 80 %, 60 %, 40 %, 20 % and 0 % of **gravity** force.

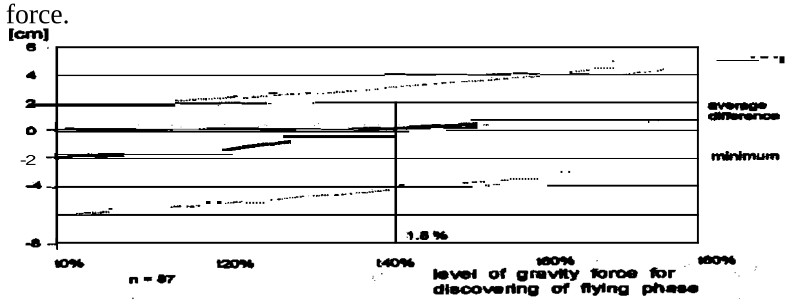
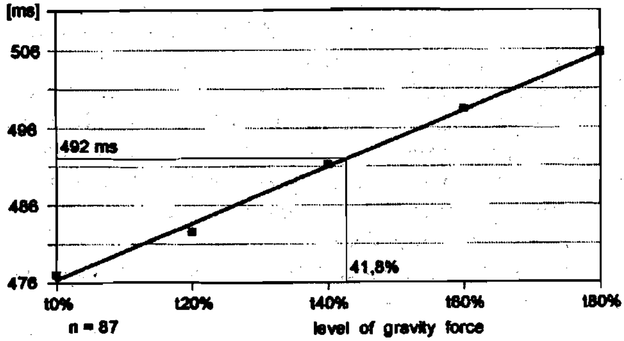



**Fig. 2**

The experimental group is consisted of 87 persons. There were 63 males (from 22 to 53 years) and 24 females (from 15 to 23 years). The group also contained the top level sportsmen, athletes, volleyball players.

The range of flying phase at 0 % gravity force was **betwen** 366 **ms** (the jump height of 16 cm) and 617 ms (the jump height of 46.7 cm). If the jump was incorrect the **attempt** was repeated. The jump height for take - off impuls was calculated by formula (2). The jump heights for flying **fhases** at different force level were **calculated** with the help of formula (3). There were differences between the jump height calculated from the take - off impulse and the jump height which was calculated from **the** flying phase at different lewels of force. The figure No 2 shows difference in the whole group. The average value of difference reaches zero level at 41.8 % of gravity force.




Fi.3

Figure No 3 shows the average period of flying phase duration concerning the different levels of gravity force. Forty one point eight percent level applies for average period of flying phase duration which equals 492 ms. As regards zero level, the average period of flying phase duration is 476 ms. Using these two numbers we can set correction for **flying** phase duration measured on a contact board at zero force level.

The corrected flying phase refers

**tfc = (492/476,4).tf0% = 1,0666.tf0%** (7)

After substituting (7) to (3) we gain for the height of the jump which is calculated from corrected flying phase

h = **(1/8).g.(1,0666.tf0%)2**

When using substitution of gravity constant g = 9.81 **m.s-2** the simple relation (8) will apply for the height of the jump

h = **1,3078.tf0%2** = **1,3.tf0%2** (8)

Putting corrected flying phase into relation (5) we can achieve the extend of take - off impulse which also includes the lift of body on the tiptoes.

## RESULTS AND DISCUSSION

Figure No 4 shows the **grafic** analysis of results while the countermovement jump was **analysed.**

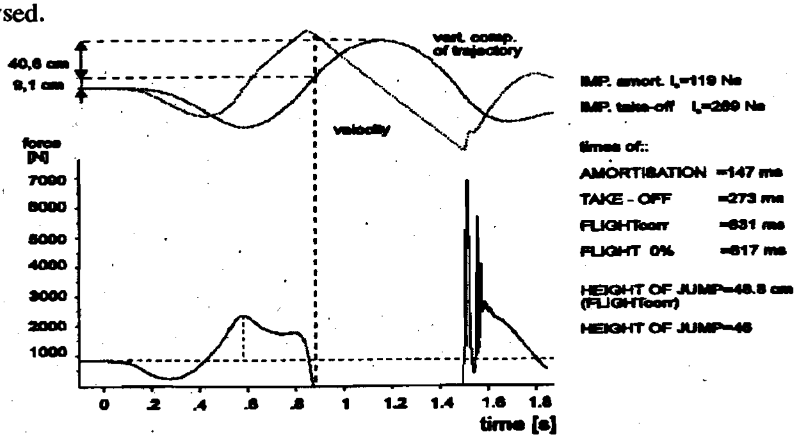



Fig. 4

The height of the jump determined from corrected flying phase is 48.7 cm. The height of the jump determined from the trajectory the gravity centre is **49,6** cm.

This consist of lift (*9.1* cm) and jupm during the flying phase (40,5 cm). The flying phase measured at *1 %* level of gravity force is *617* ms, which refers to the height of jump 46,7 cm according to relation (3). There is a difference between the height of the jump during the flying phase taken from the trajectory and flying phase which is determined according to the course of gravity force at 0 % level (40,5 cm to *46.7* cm). This difference is caused by different body position at the beginning and the end of flying phase. Because of reflex a tested person takes such body position when landing so that he could effectively smooth the maximal extend of the vertical force. Thisactivity helps to prolong the flying phase

Take - off impulse calculated from corrected flying phase using relation (8) and (5) is *269* Ns. Amortisation impulse is *119* Ns.

CONCLUSION

The research work states the procedure to reach amortisation and take - off impulse during jumps. The calculation is carried out with help of corrected flying phase of jump. It points out to cause of differences within height of jump which is taken from trajectory of body's gravity centre and flying phase of jump.

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