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Original Research

Preliminary design and testing of a Running Starting Block

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ABSTRACT

Our objective was designing and producing a mechanical starting block and then compare the results with routine starting block in sprinting. A 2D sketch was designed using SOLIDWORKS Software. The body of the starting block with dimensions of 75×22×7 cm was developed with iron alloys during two stages. Starting block pedals were designed and manufactured with dimensions of 20×12 cm. Each pedal was connected to the starting block body using a 10 cm sliding connector to have the ability to change the horizontal distance between the pedals. The results from the first sample indicated that the board had not sufficient strength during sprinting start. In the second design, inclinable pedals in selectable 30, 45, and 65 degrees fabricated with 6 mm metal plate. Twelve replaceable nails for Tartan surface mounted on the front and end nail-holder plates. In order to evaluate the starting block, 20 athletics with mean age, height, weight and history of exercise (21.6 ± 2.3 year, 178.1 ± 5.2 cm, 68.7 ± 6.1 kg, and 5.2 ± 0.8 year, respectively) evaluated their sprinting performance under supervision of two referees and five coaches using a questionnaire. By changing the design and new product, the second prototype was evaluated. The final sample indicated that the boards and pedals had sufficient strength and robustness. The level of satisfaction of runners, coaches and referees were significantly different from the traditional starting block ($p<0.05$). The Test-Retest Reliability test using the Pearson Correlation Coefficient computed from responses to the questionnaires shown perfect correlated ($r = 0.83$, $P < 0.0001$). According to the results, the final starting block had sufficient robustness and is suitable for using in the research and official competitions.

Keywords: Designing & Manufacturing, Starting Block, Track and Field, Sprinting.

Introduction

Track and field running sport has different types and track running is include short distance races like the 50-yard dash, 100, 200 and 400-meter sprints, and other races. In the past, sprinters used to dig holes in the ground to help them having a good start. In the early 1930s, athletes started to use wooden blocks to give them advantage of getting more momentum. By means of starting block, sprinter exerts an explosive force to the starting block in a very short time to produce great momentum to push the body forward. Years of experiences shown us a significant effect of this simple device on the sprint [1]. While there are different types of starting blocks, the equipment typically consists of two adjustable foot pedals (flat or slightly concave surface) attached to a rigid frame. Athletes can adjust the pedals placement according to his/her needs as well as the type of race. There are many kinematic and kinetic variables such as center of mass velocity, impulse, the rear peak force, the starting block time, the block leaving velocity and acceleration, were investigated as possible parameters influencing starting block performance [2, 3].

Running race starts with a signal usually using gun fire with blank shells. The speed of sound traveled in air is about 343 m/s at 20 °C, and varies by several meter per seconds depends on the environmental temperature. In all the sprinting competitions (≤400 m) [4], the starting commands are "On your marks" and "Set". Once all athletes are in the set positions, the starter's gun is fired and immediately starting the competition. In the 100 m race, all competitors are lined up side-by-side. For the 200 m, 300 m and 400 m, which involve curves, athletes are staggered for the start [4]. As the matter of fact, sound has limited speed and in an official race with 6-8 lanes where each sprinter has 1.22 m distance, there is considerable latency and the lower intensity of the pistols sound to hear by the last sprinter. To overcome this flaw, since the 2008

Olympic Games, one speaker placed behind of each sprinter to convey the sound of pistol shot, but another problem may be interference of speakers sound with the pistol shot. At a distance of 1.22 m between the lanes, the signal will take about 3.55 ms delay to reach another athlete's ear. When there is no individual speaker for each athlete, the signal takes 28.4 ms to reach athlete in the 8th lane and the volume of the signal will decrease considerably. Obviously, sprinters who are closer to the starter have an advantage compared to athletes who are further away from the pistol shot [5].

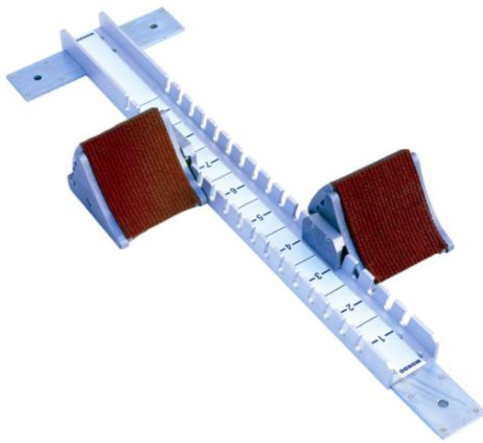

Figure 1. Traditional Starting Block

Figure 2. OMEGA Starting block and silent pistol starter system

To solve this problem, OMEGA Company at the Vancouver Olympics in 2010 switched to the "silent" pistol technology, which emits an electronic beep. Electronic Start Gun e-Start, Electronic Start System BANG, and Startbeep STB1 then introduced by ALGE-TIMING , (Rotkreuzstraße 39, 6890 Lustenau, Austria).
Technically speaking, the starting block and starting performance attracted great attention of researchers. However, the current mechanical starting blocks and traditional starting block do not allow us to extend biomechanical research on sprinting. Hence, the purpose of this project was to design and produce a mechanical starting block to be implemented in the collegiate and national competitions.

Material and Methods

First design outlines according to the IAAF roles and the current mechanical starting blocks were drafted and then mechanical drawing designed by SOLIDWORKS® software (Dassault Systèmes SOLIDWORKS Corp., Waltham, USA)(Figure 3).

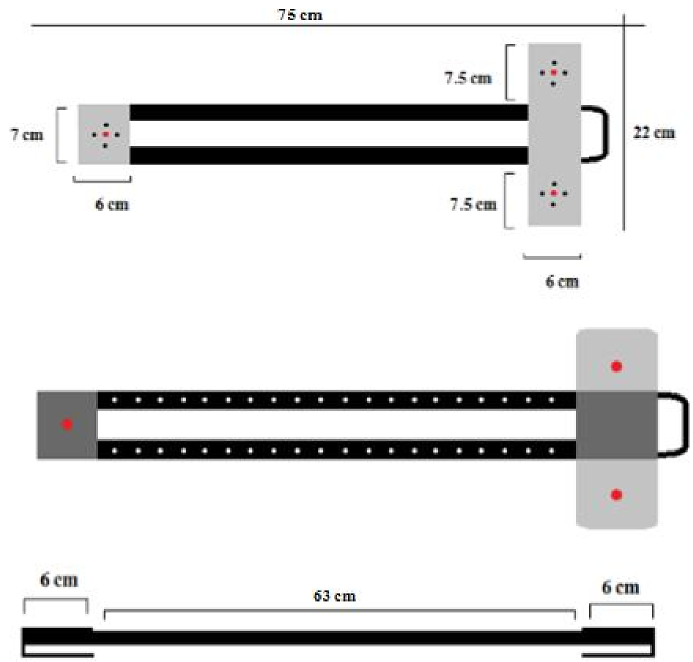

Figure 3. Starting Block drawing.

The next step was to produce the starting block using a rapid prototyping method using electrical welding. Main frame built by two parallel 76 cm of iron 1" square tubes with 5 cm distance. Main frame welded to the end pins plate (22 × 6 cm) with eight 1 cm length replaceable needles for Tartan surface and 2 holes for long nails for sand surface. Front pins plate has four 1 cm replaceable nails and one hole for long nail in the sand surface and jointed with the frame by two 10 mm diameter bolts & nuts to allow pedals to be replaceable if any amendment or replacement would needed.

Pedal (20 × 12 cm) was first made by 2 mm metal sheet but was found to be too weak during the field tests. In the second design pedal and its base were made by 6 mm thickness iron plates. Pedal and its base plate were welded to a metal surface mount hinge. In this design pedal is able to tilt at selectable 30, 45, and 65 degrees. An elegant supporting wall was designed to support the pedal from explosive force exerted during the start. To adjust pedals, holes with 3 cm distance drilled on the top-side of the main frame and a pin was designed with spring in a special pin holder to pull for sliding and adjustment according to the individual need for better positioning the foot. Pedal base was welded to this pin holder connector. Finally all the starting block was painted and according to the IAAF regulation, a 3 mm rubber pad was pasted on the pedal's surface.

Results

To evaluate the final starting block, we recruited 20 sprinters among the university students running team (21.6±2.3 years; 178.1±5.2 cm height; 68.7±6.1 kg weigh) with 5.2 ± 0.8 years running experiences under supervision of 5 coaches and three referees. Aim and objectives of the research was explained verbally to the subjects, coaches and referees. Data was collected by questionnaire approved by the experts and academic researchers and also coaches and referees. Data was taken in two experiments with ten days difference in the morning.

Shapiro-Wilk normality test and Pearson correlations were performed using SPSS (release 22, SPSS Inc., Chicago, IL). Distribution of data normality was approved by using Shapiro-Wilk normality test then, questionnaire's data were processed to do Test-Retest Reliability using Pearson Correlation. Data collected from the athletes, coaches and referees shown high approval score of satisfaction regarding pedals, frame stability and angle changes of the pedals (Table 1). The reliability of the starting block had no any significant difference in the two step evaluation ($p<0.05$) and Pearson correlation between two data collections was shown perfect correlation ($r=0.83$, $P<0.0001$).

Table 1. Results of the comparison between traditional starting block and our product

Satisfaction results during start*	Designed starting block	Traditional starting block
Pedals	82.2±3.1	78.1±4.8
Frame stability	85.81 ±4.7	76.13 ±5.1
Angle changes of the pedals	75.12±5.1	72.2±6.9

* Data obtained out of 100.

Figure 4. The first starting block.

Figure 5. The final Starting Block

Discussion

The capability to develop great horizontal forces is very important in a sprint start, not only in the blocks but in the subsequent strides [6]. Front leg is important to produce effective force (74%) during the total block phase impulse [7]. In the current device we considered anthropometrical and individual style and established facts about advantage of increasing foot spacing [8] and made it easy to select appropriate pedal position.
Hence, seems adjustable and proper positioning the foot is important in the sprinting. Current design tried to have established features necessary for having efficient starting block. After mechanical design, manufacturing and field tests we came up with approved starting block. It is cost effective, standard according to IAAF 2019 rules and regulations, and robust for training and competitions.

Conclusions

This project was just a pilot project to produce a starting block for domestic applications. It was enabled us to design a practically robust, affordable and applicable in different track and field surfaces for sprinting competitions.

References

1. Schot, P.K. and K.M. Knutzen, *A Biomechanical Analysis of Four Sprint Start Positions.* Research Quarterly for Exercise and Sport, 1992; **63**(2): 137-147.
2. Hafez, A.M.A. and E.M.S.A.A. Roberts, *Force and velocity during front foot contact in the sprint start*, in *Biomechanics*, D.A. Winter, et al., Editors. 1985, Human Kinetics: Champaign, IL. p. 350-355.
3. Fortier, S., et al., *Starting Block Performance in Sprinters: A Statistical Method for Identifying Discriminative Parameters of the Performance and an Analysis of the Effect of Providing Feedback over a 6-Week Period.* Journal of sports science & medicine, 2005; **4**(2): 134-143.
4. IAAF, *International Association of Athletics Federations,Competition Rules 2018-2019*. 2019, IAAF.
5. Brown, A.M., et al., *"Go" signal intensity influences the sprint start.* Medicine and science in sports and exercise, 2008; **40**(6): 1142-1148.
6. Harland, M.J. and J.R. Steele, *Biomechanics of the Sprint Start.* Sports Medicine, 1997; **23**(1): 11–20.
7. Bezodis, N.E., S.P. Walton, and R. Nagahara, *Understanding the track and field sprint start through a functional analysis of the external force features which contribute to higher levels of block phase performance.* Journal of Sports Sciences, 2019; **37**(5): 560-567.
8. Guissard, N., J. Duchateau, and K. Hainaut, *EMG and mechanical changes during sprint starts at different front block obliquities.* Medicine & Science in Sports & Exercise, 1992; **24**(11): 1257-1263.

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