

## Biomechanical Analysis of Hop in Triple Jump for Indian Elite Triple Jumpers

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### Abstract

The purpose of the study was to analyze the biomechanical characteristics of the take-off in hop phase in triple jump. For the investigation five (5) elite male Triple jumpers age ranged from 24-28 years were selected as subjects for the present study. All the jumpers were able with the performance in triple jump of 16m and above. The selected kinematic parameters were measured using video graphic technique in the competition situation. Subsequently, these recorded movements were analyzed using the Filmora Wondershare and Kinovea 0.8.15 software. Finally analysis of the scores was done on the basis of laws and principles of mechanics. The result confirms that all the jumpers had a decrease in horizontal velocity during take-off phase in triple jump. The mean horizontal velocity of the COM at the entry for take-off in hop phase of elite male triple jumper was 10.26 m/s. The mean horizontal velocity of the competitors at the exit for take-off in hop phase of elite male triple jumper was 9.44 m/s. The mean duration of take-off for hop phase of elite male triple jumper was 0.13 sec. Take-off angle for hop in triple jump ranges between 12-17 degrees of the elite triple jumpers in India.

**KEYWORDS:** Kinematics, Video Graphic Technique, Horizontal Velocity, COM, Take-Off Angle.

### Introduction:

The triple jump (TJ) is an athletic event comprising a run up followed by three consecutive phases. The hop(H), a take-off from one foot, landing on the same foot; the step (S), a take-off from one foot, landing on the other foot; and the jump(J), a take-off from one foot, landing in the sand pit, usually on two feet. The goal of a triple jumper is to attain the greatest possible horizontal distance. The distance covered depends largely on the horizontal approach speed, and the extent to which this can be controlled, conserved and even apportioned over the three phases: the hop, the step and the jump (Dyson, 1962; Hay, 1993). Take-off techniques differ significantly between athletes because of their individual physical characteristics. For example, the lengths of the different phases related to the total length of the jump vary between individuals (Susanka et al., 1987).

The triple jump includes the specificity of complex coordinative and technical abilities, particularly the jumping rhythm and time management, a good take-off coordination into the hop, step and jump as well as the balance (equilibration) during jumping flight. Quoted triple jump specific and performance limited characteristics are low horizontal velocity deficits during take-off phases, improvement of the jump-distance relation of H and S concerning duration, jump-height and horizontal velocity (Fukashiro et al. 1981, Fukashiro & Miyashita 1983, Yu & Hay 1996) and percentage optimization of the phase distances (H: 35-36%, S: 30-31%, J: 33-35%). In addition knee and hip angles during take-off phases seem to be quality criteria of triple jump performance (Yu & Hay 1995, Perttunen et al. 2000). The achieved distances in triple

jump (TJ) strongly dependent upon the available horizontal velocity in run-up and each of the take-offs (TO). Kinetic energy is produced through the approach speed in every TO and is converted into height and distance.

The performance is highly depends on how good the take-off was. Take-off comprises of three parts, such as Touchdown, Amortization and Touch-off. The quality of Take-off depends on various components like, horizontal velocity, conversion of horizontal velocity into vertical velocity, contact time on take-off, take-off angle etc.

The proposed study will try to analyze the technique of Take-off for hop phase in Triple Jump in special reference to those kinematic variables.

#### **Methodology:**

Five (5) male Triple jumpers age ranged from 24-28 years were selected as subjects for the present study. They were active athletes with the performance of national and international level in triple jump. They used to train themselves under the guidance of qualified coaches. All the jumpers were able with the performance in triple jump of 16m and above. They represented their respective states in senior national athletic meet and some of them also represented for India in different international events also.

The movements of the subjects were recorded using a motion capture camera in the competition situation of the 58<sup>th</sup> National Inter State Senior Athletics Championship 2018 held at Indira Gandhi Athletic Stadium, Guwahati. Camera frequency was set on 120 fps. Subsequently, these recorded movements were analyzed using the Filmora Wondershare and Kinovea 0.8.15 software. Finally analysis of the scores was done on the basis of laws and principles of mechanics.

#### **Result and Discussion:**

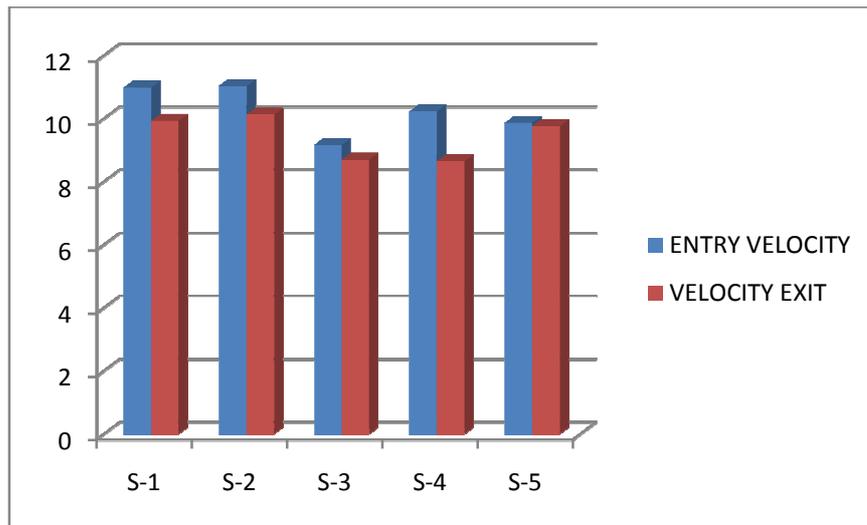
Table –I shows the velocity of com at the entry during hop

**Table-I**

#### **Velocity of com at the entry, exit and loss of velocity**

SUBJECT	VELOCITY ENTRY (M/S)	VELOCITY EXIT (M/S)	PERCENTAGE OF LOSS OF VELOCITY
S-1	10.99	9.932	10%
S-2	11.04	10.131	8%
S-3	9.17	8.703	5%
S-4	10.24	8.654	15%
S-5	9.87	9.765	1%
MEAN	10.26	9.44	8%
SD	±0.787	±0.705	0.05

The figure-I shows the velocities of the take-off phase of hop in triple jump.



**Figure-I Changes of Velocities during Take-Off**

The figure shows that the horizontal velocity the athletes carried during entry was decreased during exit this is perhaps due to the fact that the jumper converts a part of horizontal speed into vertical speed for take-off.

The Table-II shows the Duration of Take-Off and Take-Off Angle of the subjects.

**Table –II  
Duration of Take-Off and Take-Off Angle**

SUBJECT	DURATION OF TAKE OFF (S)	TAKE OFF ANGLE
S-1	0.125	12
S-2	0.125	16
S-3	0.133	17
S-4	0.133	14
S-5	0.141	13
MEAN	0.13	14.4
SD	±0.007	±2.074

The table shows the mean duration of take-off in hop phase of the subjects was  $0.13 \pm 0.007$  seconds. The take-off angle of the jumpers was ranges from 12 degree to 17 degree. And the mean take-off angle of the jumpers was  $14.4 \pm 2.07$  degrees.

**Conclusion:**

- 1) The mean horizontal velocity at the entry for take-off in hop phase of elite national male triple jumper is 10.26 m/s.
- 2) The average horizontal velocity at the exit for take-off in hop phase of elite male triple jumper is 9.44 m/s.
- 3) Horizontal velocities decreases during take-off for hop phase in triple jump.
- 4) The Average loss of Horizontal velocity during take-off for hop in Triple jump is 8%.
- 5) The average duration over the take-off board during hop phase of elite male triple jumper is 0.13 sec.
- 6) Take-off angle for hop in triple jump ranges 12-17 degrees of the elite triple jumpers in India.

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