RESEARCH ON DIFFERENT SIZES OF PLATFORM'S EFFECTS ON THE ATHLETES' LEAVING PLATFORM SPEED IN THE FREESTYLE SKIING AERIAL SKILL PROJECT

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The freestyle skiing aerial skill is an advantage project to win medals at the winter Olympic Games for China. This research applies the mathematical model method, combining theory with experiment, with the help of the athletes' leaving platform speed calculation software, to research and Analysis different sizes of platforms' effects on the athletes' leaving platform speed. The research result indicates that: the increasing of the platform height will decrease the leaving platform speed, and the decreasing range is related to the changing range. In order to ensure the specific actions' required leaving platform speed, it can be solved through adjusting the sliding distance and the speed of changing postures.

KEY WORDS: mathematical model method, calculation software, integral operation, sliding distances, transition zone distance, platform size.

INTRODUCTION: China began to carry out the freestyle skiing aerials project from the1980s. Since the project focused primarily on skills, flexibility and agility which are consistent with the sporting characteristics and physical characteristics of Chinese people, The freestyle skiing aerials has been an important breakthrough for Chinese players winning the gold medal in the Winter Olympics. The action of the freestyle skiing aerials is composed of four parts (skiing stage, jumping stage, tuck dive stage and landing stage). which are connecting and interacting with each other. One of the key factors that determine the success of the action is to control the jumping height, that is to control the leaving the platform speed.
Freestyle skier first glide at an accelerating speed in ascertains loping and slide, then jump up from the platform with different height sand complete the air movement. The difference of the size of the platform has an influence on the leaving the platform speed. This study starts from three aspects of the skiing distance, the distance of transition zone and the size of curve segment to analysis the influence on the leaving the platform speed by the size of the platform .

METHODS: The study takes the national team athletes of free style skiing aerial as the object. Firstly, the freestyle skiing athletes need to speed up sliding on a slope with certain gradient, and then jump up from different highs of platforms and accomplish aerial actions. As shown in figure 1, according to the athletes' postures changing, the sliding stages can be divided into: Start (S1), Squat Down Sliding (S2-S3), Squat Sliding (S4),Straight Up (S5-S6), Straight Up Sliding （S7), Horizontally Sliding Arm Lifting (S8-S9). It can be divided into two stages according to the change of curvature radius and air resistance (S10-S11), as shown in figure 1 . Each stage brings in different air resistance changing equation separately to calculate.

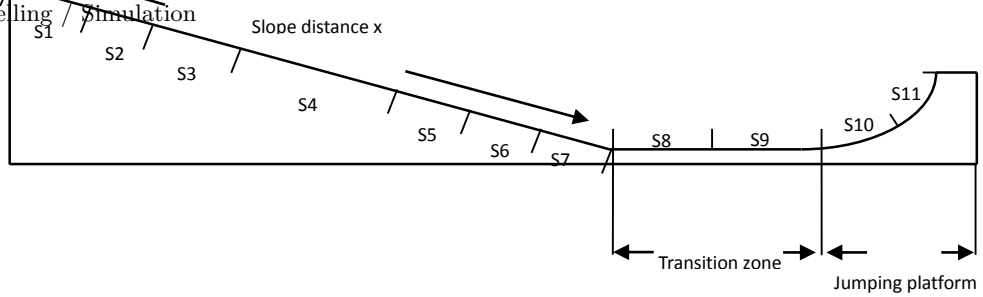


Figure 1: The athletes sliding stage dividing schematic diagram

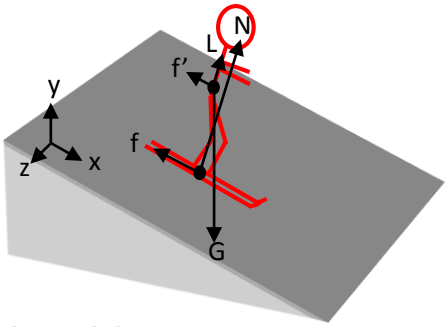


Figure 2:The figure of skiers' stress in straight segment

Considering the differences between the slope and the platform's geometrical structure, to calculate the athletes' leaving platform speed accurately, the mathematical equation is divided into two parts: one part is the straight line sections, which starts from the slope to the transition zone, where the athletes move on the surface with certain gradient or no gradient, with integral operation to select displacement as the step length; the other part is from the athletes' moving into the platform's radius to the moment of leaving the platform, because in this process, the athletes need to do circular motion on radius with certain curvature, selecting the change of angel as the step length.

In the software, the calculation of leaving platform speed's control equation uses Euler to do the calculation of two segments' ordinary differential equations. Assuming that f(x,y) in the y'=f(x,y) ($a \leq x \leq b$) is sufficiently smooth, expand y(xi+1) at point x I by Taylor. So we get

$$\begin{cases} y_{i+1} = y_i + K \\ K = hf(x_i, y_i) \end{cases}$$

According to figure2, the motion equation of direction which is along the slope of approach is as follows.

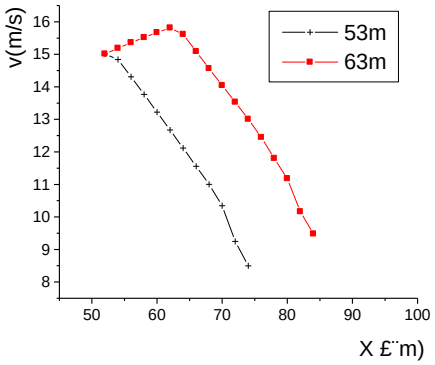
$$\frac{dv}{dx} \Rightarrow \int_{x_0}^{x} F_{(x)}\,dx = \int_{v_0}^{v} mvdv \Rightarrow v(x) \text{Formula1}$$

$$\int_0^x (f + f' + G_x + N_x)dx = m\int_{v_0}^{v} vdv \text{Formula2}$$

According to formula1, there is $dv = \frac{\sum F}{mv_i} \cdot dx$, When Δx is very small, there is $dv \approx \Delta v = K \cdot \Delta x$, so $dv = f'(x_i)\Delta x, f'(x_i) = \frac{\sum F}{mv_i}$.According to equation of ***Taylor*** expansion, the equation of speed is $\begin{cases} v_{i+1} = v_i + h\frac{\sum F}{mv_i} \\ v_0 = 0.8 \end{cases}$

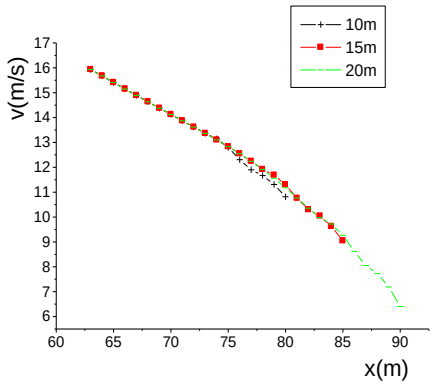
Curve equation's calculation method is the same, here is a little.

RESULTS: This study analyses the effects of sliding distance, the transition zone distance and the platform sizes changing on the leaving platform speed. The results are as follows.



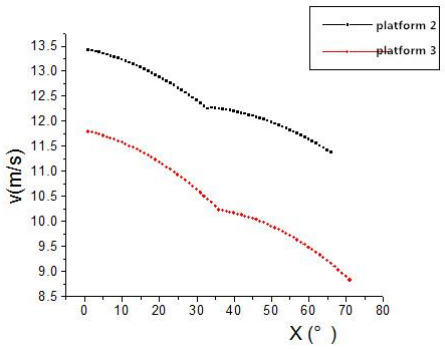
X said the sliding distance

Figure 3: Different sliding distances and athletes sliding speed changing figure



X said the sliding distance

Figure 4: The influence of the transition zone distance to the leaving platform speed



X said the radian angle

Figure 5: The influence of the platform sizes changing to the leaving platform speed

DISCUSSION: The former researches indicate that:the sliding velocity and the sliding distance are in direct proportion, and the sliding speed affects the athletes' gravity leaving platform speed. According to the characteristics of projectile motion, when the athletes leave platform, the gravity vertical speed affects the jump height, and with the higher gravity vertical speed while leaving platform, the athletes' jumping height is higher, the jumping time is relatively prolonged, and the athletes can accomplish much more difficult motions. According to input

afferent sliding distance, this paper finds that the increasing of the sliding distance will increase the leaving platform speed, as shown in figure 3. When the sliding distance increases by 10m, the leaving platform speed will increase by 1m/s, which will improve the jumping height.
The transition zone is a section of straight line zone, where the athletes should complete the speed controlling and preparation before going to the platform. But because there's no slope in this section, gravity will not play the role of acceleration, instead, the air resistance and fraction will decrease the sliding speed. So this section's distance will directly affects the speed of going onto the platform, then affects the speed of leaving platform. As shown in figure 4, when the transition distance increases from 10m to 20m, the speed's decreasing range is obvious which indicates the changing of this section's size influences largely on the leaving platform speed.
As shown in figure 5,under the same sliding distance, the jumping speed from platform 2 is higher than platform 3. That is because the curvature reads and the height of platform 3 are both higher than platform2, which leads to the increasing of resistance work, and the speed decreasing function is also increasing accordingly.

CONCLUSION: The research results show that when the slip distance increases 10m, the leaving platform speed increases 1m/s. When the length of transition zone increases from 10m to 15m and 20m, the leaving platform speed drops from 11m/s to 9m/s and 6m/s. When the slip distance is same as the transition zone length, the jumping speed from platform 2 is 2m/s higher than from platform 3. With the increasing of radian angle of platform, the leaving platform speed decrease. When the radian angle increases 5 degree, the leaving platform speed decreases 0.2m/s.

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Acknowledgement
This work was financially supported by the National Natural Science Foundation (11102120).