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Snowboard U ski resort flight height and flipping technique dynamical analysis

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ABSTRACT

Dan Ban Hua Xue English word is Snowboard, the sport is born in America in 1960s, its cause is related to surf riding. Since it was introduced in China since 2003, by long-term training and groping, China has achieved certain performance in the event, at present it also is Chinese relative advantageous snow sport. Among them, takeoff height is the key to flight phase, motions difficulties, motion quality as well as fluency in the air decides athletes' performances and also competitions final results. The paper, by proper hypothesis, simplified models, according to principle of conservation of energy, it analyzes and solves dynamics and sport state to athletes, gets flight height differential equation, and analyzes each factor influences on flight height. From the perspective of objective theory, it discusses increasing flight height method, and gets technique how to increase flight height.

KEYWORDS

Snowboard;
Conservation of energy;
Flight height;
U ski resort.

INTRODUCTION

Snowboard is very popular in Europe and America, which is well received by skiers. The sport, is full of risks and stimulation, during the sport, it accompanies with music and full of passion. Athletes, with the help of a piece of snowboard tool in U court, according to rules requirements, they go through approaching, going down, taking off, falling back four segments back and forth, finally slip off the track, giving performance by motion exhibition when flying, continuous fulfill 5 to 8 motions. China according to northeast unique environment advantage introduces snowboard into domestic since the beginning of the century and develops it rapidly, which achieved excellent performance in Olympic Winter Games. But comparing with foreign first class players, Chinese athletes still have certain gap, especially in high difficulty motions they still fall behind opponents.

For U court ski motions technical analysis, previous people have made many researches, which provides theoretical basis for Chinese athletes training and also open the way for the later researching. Xiao Ning-Ning etc. makes research on technical motions features, they analyzed and researched on technical motions completion skills from the perspective of biomechanics by documents investigation, on-site inspection comparison, and proposed constant improving technical difficulty is the key to win. Liu Jin-Lei etc. adopted videos, observation and expert interview collecting lots of information when researching motions completion ability and behaviors. High difficulty motion completion success rate objectively is up to flight speed and height so on; it subjectively is closely related to athletes' physical and psychological quality. Liu Shi etc. made research on snowboard U court technical theory development, and found Chinese sports postures have unique advantages in the sport. Wu Feng-Yu put emphasis research on technical motions and system relations, made deeply research from physical quality indicators, and made reasonable suggestions. Li Xiao-Dong etc.by difficulty motions technical elements analysis and researching, they got techniques' key points that key technical factors were increasing ski speed, improving flight height, increasing difficulty coefficient. Above research mostly researches motion features by starting from expert interviewing, experiences and comparison angles. It gets flight height is very critical.

Starting from theoretical angle, explore and research develop snowboard U court techniques is the fundamental direct and effective method, it can provide powerful evidence for athletes' training, equipment's installing and motions techniques. The paper carries out kinematic and mechanical analysis and research flight height influences in athletes' sport process, in the hope of providing theoretical guiding for athletes' completing high difficulty motions.

AFTER FLYING CORRELATION TECHNIQUES INFLUENCE FACTORS ANALYSIS

U ski resort, as the name suggests its court is U groove. Athletes enter into U groove by ski-jump ramp, falls at certain initial speed, in the track after skiing with the help of track drop and existing initial speed takeoff, flies out of track and completes technical motions in the air. Every place court parameters are different, they have length, slope, depth as well as width (compose of two sides' semi-circle radius and track bottom wide flat) differences, takes Vancouver Olympic Winter Games as an example, track sizes is 160m long, 18m wide, 6.7m deep and average slope is 18°,as following Figure 1.

Flight height: it refers after athletes taking off, the maximum vertical distance from track edge in the air. Hang time: it refers athletes' takeoff leave track edge to falling into track time that is hang time in the air. Flight height decides hang time, and hang time mainly decides air difficulty motions completion quality. Athletes in sport

Figure 1 : U court skiing process

process speed can decompose into cross section plane vertical plane and longitudinal section horizontal parallel to track direction movement. In the following, it only discusses cross section plane vertical speed and simplified analysis dynamical model. At first, it makes hypothesis as following: 1.ignore air resistance influences, 2. Track is semi-circle type, 3 no faults in sport.

Force analysis

As following Figure 2, athlete in tracks any point A, it makes force analysis of track athletes in cross section as Figure 2 show. Among them, F_c represents athletes suffered centripetal force, F_n represents athletes suffered support force, F_f represents athletes suffered friction resistance, $mg\sin\theta$ represents gravity component force, mg represents athletes' gravity. As Figure 2 shows:

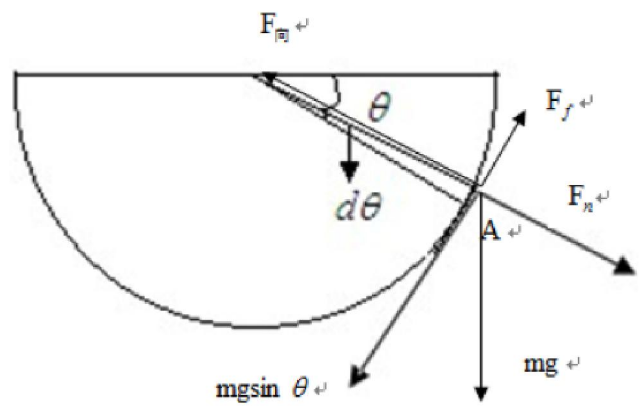

Figure 2 : Track section schematic diagram

Calculate flight height

Ignoring athletes' subjectively themselves acting, just starts from pure theory objective conditions, according to energy conservation, it is clear that:

$$\frac{1}{2}mv_1^2 = mgh \tag{1}$$

It gets flight height:

$$h = \frac{v_1^2}{2g} \tag{2}$$

Among them, v_1 represents athlete speed when flying, h represents maximum flight height, m represents athlete mass, g represents gravity accelerated speed.

Enter into track to next adjacent flight, according to energy conservation, it gets equation as following:

$$\frac{1}{2}mv_0^2 - E_s = \frac{1}{2}mv_1^2 \tag{3}$$

Then:

$$h = \frac{mv_0^2 - 2E_s}{2mg} \tag{4}$$

Among them, E_s represents friction force acting in process, v_0 represents athlete speed when entering into track. Initial speed decides high flight, and friction force hinders flight height. Thereupon, the key to high flight is the solution of friction force acting, friction force acting gets smaller, its flight height will increase.

Adopt differential calculus to solve friction force acting, its analysis process graphic is as Figure 2 shows. Athlete moves to any angle θ position, takes angle infinitesimal $d\theta$, then arc length infinitesimal is $rd\theta$, in figure athlete is moving clockwise. Further infinitesimal arc length acting:

$$dE_s = \mu F_n(\theta) r d\theta \tag{5}$$

By above force analysis, A point athlete force in vertical movement direction:

$$F_n(\theta) = \frac{mv_\theta^2}{r} + mg\sin\theta \tag{6}$$

Among them, $F_n(\theta)$ represents athlete to tract positive pressure, is function about θ; v_θ represents speed size when athlete at angle θ.

When athlete just enters into track and the state forms angle θ with track, apply kinetic energy theorem, it solves:

$$\frac{1}{2}mv_\theta^2 - \frac{1}{2}mv_0^2 = mgr\sin\theta - E_s \tag{7}$$

By (5) (6) (7), it gets E_s regarding θ differential equation:

$$\frac{dE_s}{d\theta} = r\mu(\frac{mv_0^2 - 2E_s}{r} + 3mg\sin\theta) \tag{8}$$

The equation solution:

$$E_s = e^{2\mu\theta}\ (3mg\mu r\frac{2\mu\sin\theta - \cos\theta}{1+4\mu^2} + \frac{mv_0^2}{2}) + C \tag{9}$$

Among them, e is natural logarithm; μ represents snowboard and snow surface friction coefficient (0.03-0.05); C is arbitrary constant. The solution is differential equation (8) general solution. From realistic condition, it is clear when θ is 0, positive pressure $F_n(\theta)$ is 0, at this time friction force acting E_s is equal to 0, according to the condition, it solves differential equation general solution is:

$$E_s = e^{2\mu\theta}\ (3mg\mu r\frac{2\mu\sin\theta - \cos\theta}{1+4\mu^2} + \frac{mv_0^2}{2}) \tag{10}$$

Above result is relative complicated that not beneficial to factor analysis, due to μ value is smaller, its square value can be ignored, and then above result further simplified that is approximately equal to :

$$E_s = e^{2\mu\theta}[3mg\mu r\ (2\mu\sin\theta - \cos\theta) + \frac{mv_0^2}{2}] \tag{11}$$

Input result (11) to formula (4), it gets final result, flight height is:

$$h = \frac{v_0^2 - 2e^{2\mu\theta}[6g\mu r\ (2\mu\sin\theta - \cos\theta) + v_0^2]}{g} \tag{12}$$

Above result is flight height computational formula, from formula (12), it can obvious observe flight height influence factors. Increase going down initial speed can obvious improve flight height, and reduce friction coefficient can also increase flight height, and can increase next going down initial speed, which also affects next motion. Therefore, in the following it will analyze friction coefficient reduction method.

Friction factors analysis

Step on snowboard can slide in the snow surface; such principle is due to snow suffered pressure increasing, its melting point decreases, under people and snowboard pressure, snow under snowboard melts instantaneously, forms into a liquid film that exists between snow surface and snowboard, forms into lubrication that let snowboard can slide. Therefore, pres-

FULL PAPER

sure increase in a certain range, the lubrication effects will get better, it can reduce friction coefficient so that increase flight height.

As above Figure 3 shows, solidus line and temperature relation almost in straight line and slope is negative, which represents pressure increases, ice melting points will reduce. G point is ice melting point temperature under normal atmospheric pressure that is zero degrees centigrade. From the perspective of thermodynamics, it can make simple explanation on it as : ice melts into water, volume diminishes, external pressure gets bigger, external acting gets more when ice melting, ice inner energy increases more, ice will more easy melting. But reduction range is not big, roughly increase one atmospheric pressure, ice melting point will reduce 0.0075°C.

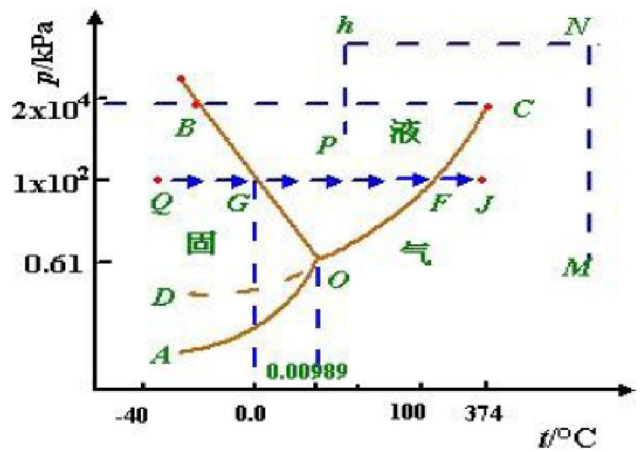

Figure 3 : Water three phases' diagram

When snowboard area is S , athlete and equipped mass total gravity is G , assume that snowboard ground is plane, and then snow surface suffered pressure is:

$$P = \frac{G}{S}$$

Reduce friction coefficient problem will convert into how to increase pressure problem, from above formula, it is clear that reduce snowboard to ground contact area, and increase total weight in limited range will helpful for pressure increasing, reducing friction coefficient, and increasing flight height.

SOMERSAULT MOVEMENT ANALYSES

When athlete leaves track, at that moment due to height H cannot ignore, head and step speed is different, sport speed is generated due to athlete body twist in the air, for the twist degree, we can use body rotated angle α to measure. Assume people gravity center lies in the half height position,

Then athlete gravity center angular speed:

$$w = \frac{v_{01}}{r - H/2} \quad (13)$$

In formula: v_{01} is athlete himself average speed when flying.

Head speed:

$$v_{head} = w*(r-H) \quad (14)$$

Foot speed:

$$v_{foot} = wr \quad (15)$$

After flying foot speed is quicker than head speed, set head static moment, foot relative head speed is:

$$\Delta v = v_{foot} - v_{head} = w*H = \frac{2v_{01}}{2\frac{r}{H} - 1} \quad (16)$$

Relative to head angular speed is:

$$w' = \frac{\Delta v}{H} \quad (17)$$

Flight time is approximately:

$$t = \frac{v_{01}}{g} \quad (18)$$

Then in case people not acting after flight, rotational angle is:

$$\alpha = w' t = \frac{2v_{01}^2}{(2r - H)g} \quad (19)$$

To special track that r is constant, in order to generate larger body twist, athlete can adopt bending knees or stooping and other motions to reduce H and increase body rotational angle α . Athlete height is constant, when is fixed, it can reduce flight moment track curvature radius to increase twist degree. Meanwhile athlete can also increase somersault angle by not exerting his own waist.

CONCLUSIONS

This paper makes further analysis by mechanics, kinematics and energy conservation aspects to snowboard U track technical motions, from observable theoretical perspective, it excavates flight and flips influence factors. For simplified model calculating and easier to analyze movement process, the paper makes some hypothesis so as to ignore unnecessary factor conditions. By research, it finds out athletes maximum limits generated "vertical somersault" condition is when increasing going down initial speed, it can increase flight height; adopt well techniques snowboard to reduce friction coefficient, reduce friction force acting, it can increase flight height; limited increase weight can increase vertical flight height; reduce snowboard and snow surface contact area can increase flight height; lower height athlete has an advantage when making somersault motions. Athletes can adopt bending knees or stooping motion to increase body somersault angle.

REFERENCES

[1] Li Xiao-Dong, Li Xing-Zhou; Technical Key of Improving Chinese Half-Pipe Snowboarders' Competitive Motions[J]. China Winter Sports, **33(4)**, 31-35 **(2011)**.

[2] Yang Ali; Establishment of The Mental Training Monitoring System about Snow Skills Athletes In Freestyle Skiing Aerials' and Half-pipe Snowboard's-Case[J]. Journal of Shenyang Sport University, **30(1)**, 52-54, 61 **(2011)**.

[3] Yang Ali; Mental Training of China Half-pipe Snowboarding Team for 2010 Vancouver Olympic Winter Games[J]. Journal of Shenyang Sport University, **29(1)**, 26-30 **(2010)**.

[4] Song Wen-Li, Li Xiao-Dong; Investigation and Analysis about Snow boarding Half-pipe Athletes, Knee and Wrist Joints Injury[J]. China Winter Sports, **29(6)**, 19-22 **(2007)**.

[5] Wang Bao-Heng; Thoughts of Basic Slipping and Flying Height in the Half Pipe[J]. Journal of Shenyang Sport University, **24(2)**, 71-73 **(2005)**.

[6] Tang Yusong, An Linbin,Wang Pengcheng; Report of the national halfpipe field single- board skiing skill series championship[J]. China Winter Sports, **3**, 26-29 **(2005)**.

[7] Fan Chun-Lai, An Lin-Bin, Luo Yong-Sheng; Countermeasure on the Sustainable Development of Chinese Half-pipe Snowboard Event[J]. China Winter Sports, **30(2)**, 22-25 **(2008)**.

[8] Luan Hai-Yan, Jiang Hong-Bo; Countermeasure on Accelerating the Development of Chinese Half-Pipe Snowboard, Investigation Report of Half-pipe snowboard competition in the 11th National Winter Games[J]. China Winter Sports, **30(4)**, **(2008)**.