STUDY ON THE INFLUENCE OF CHANGES OF AIR RESISTANCE ATHLETES' TAKING-OFF SPEED IN FREESTYLE SKIING AERIALS

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Freestyle skiing is a competitive sport in the open-air environment. The air resistance that athlete meets in the process of slipping, transition and entering stage determines the athletes' taking-off speed, thus affecting the performance in competition. This paper set up a function model of frontal area and time about L, T, F, DF, F and other single action in the process completed, and establishes the function between windward area and time in specific action. It studies and analyses the influence of air resistance on athlete's taking-off speed, combining with the results of the taking-off speed calculation software. The main findings are shown as follows: When the wind speed each increases 0.8 m/s in the leaving platform phase, athlete's taking-off speed will decrease 0.4m/s. When the wind speed is low, the change of wind direction exerts little impact on athletes' taking-off speed.

KEY WORDS: research, reverse modelling, three-dimensional solid model, the finite element method, the flow field model, calculation software

INTRODUCTION: Our country began to carry out the project of Freestyle Skiing Aerials from 80's in 20th Century. Because main outstanding skills, flexibility and agility in the project are in line with its motion characteristics and physical characteristics of Chinese, the Freestyle Skiing Aerials has become an important breakthrough of Chinese players in the Winter Olympics gold medal of the project on the snow. The air resistance is affected by the change of the frontal area, changed with the change of posture when athletes pedal to accelerate in the different positions on slope. So we should consider the changes of players sliding posture and sliding speed when we calculate the air resistance. Finally, we researched and analysed the influence of air resistance on athlete's taking-off speed by simulating the air resistance, established a mathematical equation, and got the function of the change of air resistance in sliding process.

METHODS: In this study, we chose the Freestyle Skiing Aerials athletes of China as the research objects. According to the theory of reverse modeling, we established a three-dimensional solid model player (athletes' surface is divided into 87 seamless patches) by small plane modeling, repaired the arrancar and entity processes[1-2] in 3D virtual design software. Geomagic Studio with more than 200,000 points cloud data generated by our outstanding freestyle athletes used 3D laser scanner (3D body scanner in Beijing Sport University --Anthroscan 3D VITUS), as shown in figure 2. Adopting the module insert/merge and inherited functions of 3D virtual design in pro/ENGINEER, established the flow field around the space model of athletes, as shown in figure 3. Finally, Import into the Adina software to calculate resistance of air and lift by using the established flow field around the space model of players.

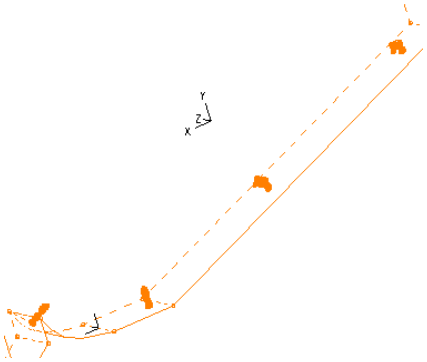

Figure 1: The flow around space model in the sliding process

Figure 2: 3D entity model of in the curve segments

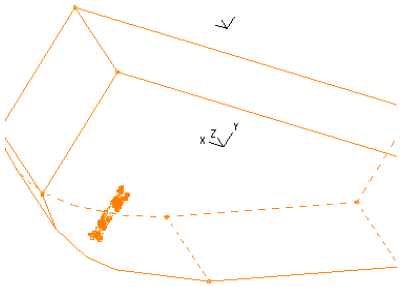

Figure 3: The flow field around the space model curve

RESULTS: Effect of air on freestyle players' action effect is huge. Air resistance of athletes is resultant of forces by force of pressure and friction. It can calculate by solving the flow field of the athletes. The control equation of the flow field around a player is the turbulence model[3,4]. The finite element method[5] is used to solve the governing equation. The established flow field space model mesh rezoning (divided into more than 80,000 units), as shown in figure 4. Considering the large velocity gradient in the relatively of boundary layer closed to the surface of the athletes and complex surface of athletes, The grid division of the surface on athletes is specially thickened, as shown in figure 5.The surface of athletes and snow road were defined as the wall in the calculation (athletes surface as the moving wall). And the rest of the surfaces were open surface. In this study, supposed the game environment temperature is -20℃ (density and dynamic viscosity of air are 1.395kg/m3, 1.62 ×10-5Pa·s).

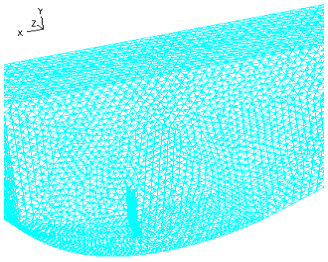

Figure 4: Mesh of the space model in flow field

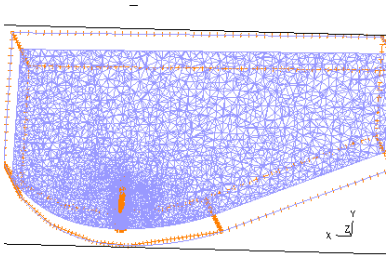

Figure 5: Thicken mesh of athletes' surface

Through the calculation, this paper has obtained the influence of taking-off speed by wind speed and direction against the wind. The results are shown in figure 6 and figure 7.

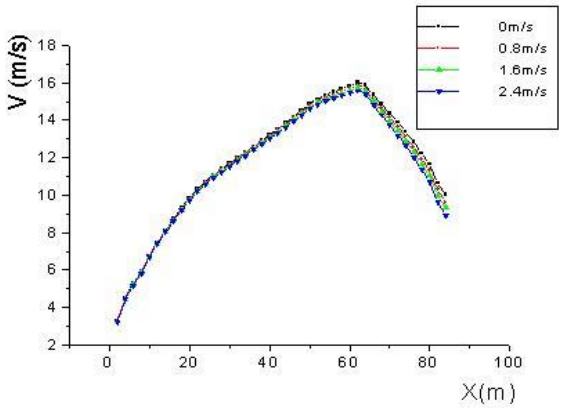

Figure 6: Effect of taking-off speed by different wind speed

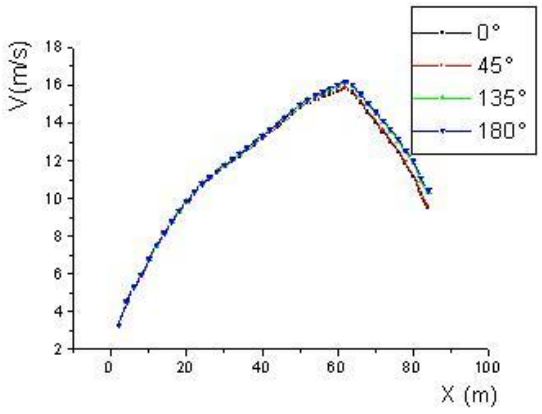

Figure 7: The impact of changes in wind direction on taking-off speed (wind speed is 0.8m/s)

DISCUSSION: Considering the influence of wind on the taking-off speed, the first one is the effect of wind speed. When wind speed is higher, it will exert more influences. The second one is the direction of the wind. The speed increases with the wind, and the speed slows down against the wind. In order to increase the realization of the model, in the study wind direction is set as 0 degree, 180 degree, 45 degree and 135 degree respectively. In accordance with the international customs of the game, when the wind speed is too high, the game will be stopped. In order to ensure the safety of athletes, the wind speed is set as 0--3m/s.

As can be seen from Fig. 6, the taking-off speed will reduce with the each increase of wind speed. When the wind speed each increases 0.8m/s in the leaving platform phase , the taking-off speed will reduce 0.4m/s.

As can be seen from Fig. 7, the influence of changes of wind direction on taking-off speed is small when the wind speed is low. But when the wind speed increases, the influence will increase.

CONCLUSION: The taking-off speed will reduce with the increase of wind speed. When the speed of increases by 0.8m/s, the taking-off speed will reduce 0.4m/s compared with the windless condition. The influence of changes in wind direction on taking-off speed is small when the wind speed is low. But when the wind speed increases, the influence will increase.

In the game, we can compensate the influence of wind speed by increasing 10m sliding distance or squat speed.

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