Aerodynamic Characteristics of the Badminton Shuttlecock Shortly After Smash

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Problem Statement and Purpose

First, the difference in deceleration rate of feather shuttlecock and nylon shuttlecock in flight experiments are not clearly proved. Next, the aerodynamic characteristics of shuttlecock at speed of 200km/h or higher are not very clear. Lastly, there is not much research on hybrid shuttlecock.

In this experiment, the deceleration rates of the initial and final speeds of the feather shuttlecock and nylon shuttlecock were calculated in the flight trajectory experiment, and the aerodynamic characteristics of the shuttlecock shortly after smash were obtained. To clarify, we will calculate the drag coefficient at 200 km/h or higher. Then, in the future, the purpose is to improve the device.

Methodology

In measurement of the deceleration rate of the initial speed and the final speed, an indoor facility without windflow was used, and two players hit a feather shuttlecock and a nylon shuttlecock at distance of 10.05m and the data were photographed for 15 times. In addition, 10.05m from the hitting point to the falling point is the average distance from the rear end of the badminton court, to the center of the badminton court. High-speed camera is used to shoot the flight trajectory of the shuttlecock from the side at 1000 fps. In addition, shooting was performed from the initial velocity at the time of launch to the final velocity 0.5 seconds after the smash.

Results and Discussion

Deceleration rate of initial speed and final speed

From comparing the initial and final velocities of the feather shuttlecock and nylon shuttlecock, it was confirmed that the feather shuttlecock was faster than the nylon shuttlecock. The initial and final velocity of feather shuttlecock for player 1 was 405.68 km/h and 55.15 km/h respectively. The initial and final velocity of nylon shuttlecock for player 1 was 420.27 km/h and 66.24 km/h respectively. From this result, both the feather shuttlecock and the nylon shuttlecock decreased significantly after 0.5 seconds. it was found that the deceleration rate of the feather shuttlecock was 0.65% to 2.2% higher in players 1 and 2, but when focusing on the numerical value of the deceleration rate, there was no big difference.

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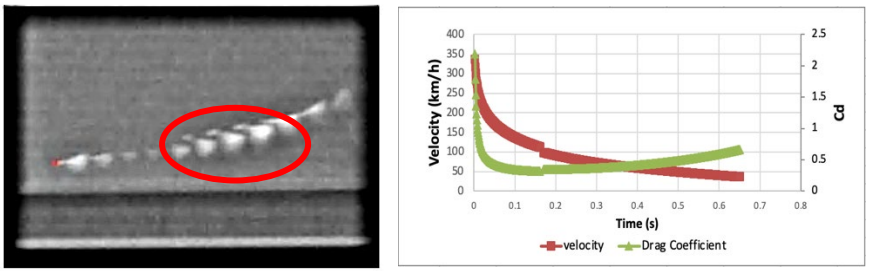
Flight attitude of Shuttlecocks and Calculation of Drag Coefficient

Fig. 1a shows the orbits of the shuttlecock with respect to the direction of travel of the feather shuttlecock during the flight trajectory experiment, which were taken with a high-speed camera. From Fig. 1a, it can be confirmed that the cork of the shuttle is tilted upward with respect to the direction of travel during flight in the feather shuttlecock. It was also confirmed that the angle when the shuttle was tilted upward was about 38.8 ° for the feather shuttlecock and about 50.1 ° for the nylon shuttlecock with respect to the direction of travel. Next, Fig. 1b shows the combination graph between the velocity, drag coefficient and time of the feather shuttlecock. Because of the velocity that we got from the experiment are unevenly scattered, the least-squares method is used to approximate the curves, and the drag coefficient is obtained. Focusing on the drag coefficient of 200 km/h or higher, the drag coefficient decreased by 73% from 300 km/h to 200 km/h for the feather shuttlecock, and about 1.6 to 0.38 and 76.3% decrease in the drag coefficient for the nylon shuttlecock. From the result, the drag coefficient tends to decrease significantly with the decrease in speed in the range of 200 km/h or higher for both the feather shuttlecock and the nylon shuttlecock. In the range of 100 km/h or less, the drag coefficient of both the feather shuttlecock and the nylon shuttlecock increase as the speed decrease.



(a) (b)

Fig. 1: (a) Angle of feather shuttlecock, (b) Drag Coefficient of feather shuttlecock

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