AERODYNAMIC CHARACTERISTICS ON A RUGBY FOOTBALL

Kazuya Seo[1], Osamu Kobayashi[2], Aya Gotsu[1] and Masahide Murakami[3]
[1]Faculty of Education, Yamagata University, Japan, seo@e.yamagata-u.ac.jp
[2]Department of Aeronautics and Astronautics, Tokai University, Japan
[3]Institute of Engineering Mechanics and Systems, University of Tsukuba, Japan

INTRODUCTION

Rugby players have understood spinning the ball around its longitudinal axis gives it more flight distances in a touch-kick and a long pass. Moreover, the spinning pass is easier to catch because of the stability resulting from the gyro effect during the flight. However there is little aerodynamic data (Rae 2002) for a rugby football.

We have measured aerodynamic forces on a spinning rugby football as well as those of a non- spinning ball for the purpose of a more efficient flight. The question is how the aerodynamic forces are different between the spinning ball and non-spinning ball.

METHODS

A full size model of a rugby football was mounted in a low-speed wind tunnel at the Department of Aeronautics and Astronautics, Tokai University, Japan. Fig. 1 is the back view of our experimental set-up. The model was a real rugby football with a spinning axis of stainless steel inserted along the longitudinal axis, urethane foam surrounded spinning axis. The spinning direction was counterclockwise around the longitudinal axis from the front view. The wind speed was set at 20 $m \cdot s^{-1}$. The spin rate of a ball was set from 0 to 4.7 revolutions per second (r.p.s). The angle of attack, which is the angle between the longitudinal axis of the ball and the direction of the flight path, was varied from 0 to 46°. Six aerodynamic forces, which were the drag, the lift, the side force, the rolling moment, the pitching moment and the yawing moment, were measured by six-component platform balances.

Figure 1: A back view of the experimental set-up.

RESULTS AND DISCUSSION

Drag coefficient C_D with respect to the angle of attack α is shown in Fig. 2. The definition of C_D is the drag divided by the dynamic pressure and the cross-sectional area of the axial midplane.

The spin rate is taken as a parameter. The ball's seam position is vertically downward at 0 r.p.s. It is seen that C_D increases with the increase of α. There is a little difference between the data of the spinning ball (0.7 & 4.7 r.p.s.) and those of the non spinning ball (0 r.p.s.), though the difference is little between the data at 0.7r.p.s. and at 4.7 r.p.s.

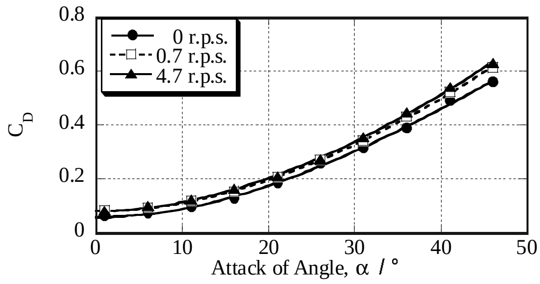

Figure 2: Drag coefficient C_D as a function of the angle of attack α.

Side force coefficient C_S at α=21° with respect to the spin rate is shown in Fig. 3. It is found that C_S decreases steeply from 0 to 0.7 r.p.s, and then it slightly decreases with the increase of the spin rate. This decrease could be explained by the Magnus effect.

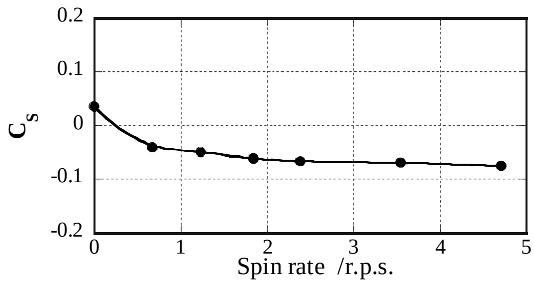

Figure 3: Side force coefficient C_S as a function of the spin rate at α=21°.

SUMMARY

Aerodynamic forces acting on a rugby football were measured. The key findings can be summarized as follows.

1. There are force differences between the data of the spinning ball and those of the non spinning ball.
2. Side force is affected by the Magnus effect produced by the spin.

REFERENCES

Rae, W.J. and Streit, R.J. (2002). *Sports Engineering*, **5**, 165-172.