EFFECTIVE USE OF A WIND TUNNEL FOR SKI JUMPING SUIT RESEARCH

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INTRODUCTION

Wind tunnels have traditionally been used to study the aerodynamic properties of the objects whose performance is highly dependent on the aerodynamic forces generated by air flow. Ski jumping is certainly one of those areas where the wind tunnel research provides a great possibility to improve the understanding of successful performance [1]. This abstract gives examples of experiments which have been used to study the effects of ski jumping suit design on jumping performance (i.e. jumping distance). This was done by applying wind tunnel results to a computer simulation.

METHODS

The wind tunnel of the laboratory of aerodynamics at the Helsinki University of Technology was used for the experiments. The wind tunnel characteristics are as follows:
- Göttingen-type closed circuit tunnel
- Closed test section, height 2 m, width 2 m and length 4m
- Velocity uniformity in the empty wind tunnel 0.1 %
- Turbulence level in the empty test section 0.1 %
- Top speed 65 … 70 m/s

In order to observe the small differences between different jumping suits living jumpers can not be used in high accuracy measurements because of the low reproducibility of flight positions in consecutive trials. Therefore two doll models (full-scale and 67 % model) have been used in the experiments with and without skis (figure 1).

Figure 1: A full-scale doll model with the frame suspended from the wind tunnel balance.

A typical measurement session consisted of blowing the wind at a kinetic pressure of 470 Pa (approx. 100 km/h) over the wide range of different ski angles of attack (18 - 46°). The position of the jumper/skis system was adapted from the typical modern ski jumping pose. Comparisons have been made between suits of different size, thickness, air permeability etc. The effects of suit modifications provided by FIS equipment regulations have also been tested.

RESULTS AND DISCUSSION

The overall importance of the ski jumping suit on performance is well demonstrated in figure 2 where the aerodynamic lift/drag relationship between the naked and dressed doll is presented. The difference in jumping distance in an HS - 135 m hill can be as much as 20 - 40 m depending on the suit design.

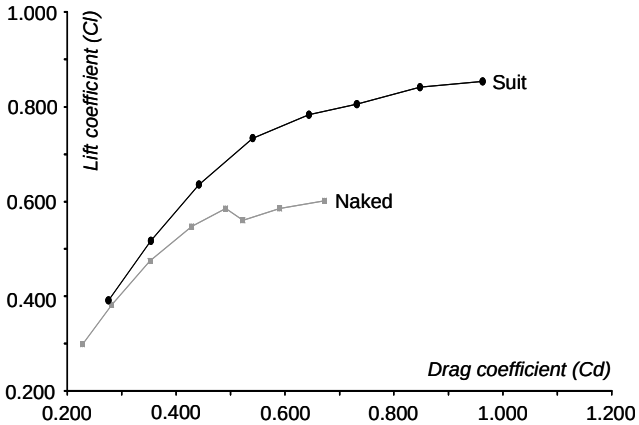

Figure 2: Lift/drag relationship between the dressed (suit) and naked doll. The data points create so called "lift/drag polar" measured with eight different ski angles of attack (18-46°, from left to right). Small angles represent the early flight phase whereas large angles (30°→) correspond to the latter part of the flight.

The suit neck line modifications in figure 3 did not have any effect on the aerodynamic forces or the jumping distance. This was surprising since FIS restricted the neckline diameter just in order to avoid modifications that were used before the new regulation was set.

Figure 3: The effects of neckline diameter and modifications were tested. The shape of the neckline (right) was emphasized by inserting a thin steel wire to the seam of the suit.

High accuracy wind tunnel measurements can reveal the very small differences (<1%) between the suits and therefore wind tunnel experiments should be used always when new regulations on the suit design are applied.

REFERENCES

1. Mahnke R, and Hochmuth, G., *Research Report from Forschungsinstitut für Körperkultur und Sport*, Leipzig, 1990.