Aero
SPEEDARMS

ENGINEERED FOR PERFORMANCE

Technical report

Summary

Improving aerodynamic performance is a constant challenge for paraglider pilots and paraglider designers, as it directly influences the glide ratio and flight experience of pilots. This study aims to reduce the aerodynamic friction generated by the pilot's arms and thereby positively influence the improvement of the glide ratio of the combined equipment. Niviuk's R&D team investigated various solutions, concluding that the use of a fabric with a certain surface roughness on the pilot's sleeves is the most effective and versatile option.

In collaboration with a major sports fabric manufacturer, several fabrics were developed and evaluated in the wind tunnel at KTH University in Stockholm, Sweden. The experiments, at speeds ranging from 18 km/h to 90 km/h in different flying positions, demonstrated that one of the fabrics produced offers an aerodynamic improvement of up to 25% compared to the current fabric used in our R-Series Speedarms. This improvement remains optimal over the entire speed-range of the most common paragliders. In addition, it was found that the position of the sleeve seams in the most common cases of manufacture does not affect aerodynamic performance, as shown in Fig. 5 and Fig. 6.

Niviuk has decided to utilise this innovative fabric in the new Aero Speedarms in line with its 'Beyond the Glide' philosophy: to provide advanced tools for all pilots to improve their flight performance.

Introduction

The goal of any paraglider pilot is to improve their glide ratio, defined as the ratio of distance flown horizontally in still air for every foot of altitude lost. Glide depends on the aerodynamic lift of the glider and the friction generated by the whole aircraft, which includes the wing, the lines, the harness, the pilot and accessories. The pilot's arms generate significant friction due to their direct exposure to the air. Reducing this friction is crucial to improving glide performance.

Figure 1. Pilot flying the Drifter 2 with their arms exposed to the wind.

Niviuk's R&D team has investigated the various physical phenomena that can result in a substantial reduction in the aerodynamic friction generated by the pilot's arms. This report summarises the methodology used and presents the most effective solution that maximises the glide ratio.

Niviuk, after extensive research, identified several solutions to minimise the aerodynamic friction caused by the pilot's arms. The most effective and versatile solution was to use a specially aerodynamically designed fabric for the sleeves of the technical garments worn by the pilots, known as speedarms.

In strategic collaboration with a manufacturer of technical fabrics for sport, Niviuk has developed and approved various embossed fabrics, which have been evaluated for their aerodynamic performance in different flight conditions. The analysis were carried out in the wind tunnel at KTH University in Stockholm (Sweden), which has a test section of 2 m wide x 2 m high x 5 m long. Thanks to the wind tunnel's dimensions and technical characteristics, it was possible to analyse the fabrics on different full-scale models of human arms.

Four different fabrics were tested, including the reference fabric of the current R-Series Speedarms. These fabrics were studied on two full-scale human arm models, replicating the most commonly used positions in paragliding flight, such as flying the glider at trim position (Fig. 2) and the accelerated flight position (Fig. 3). These positions were tested at various air incidence angles to assess their performance in crosswinds and for different angles of attack, as well as different pilot arm inclinations during real flight. In addition, the study was conducted at speeds ranging from 5 m/s (18 km/h) to 25 m/s (90 km/h), in order to get a more extensive view of the behaviour of the fabric beyond the usual paragliding speed range. More than 500 tests were carried out inside the tunnel to help determine the best technical solution for different flight configurations.

Figure 2. Flying at trim position tested with R-Series Speedarms fabric.

Figure 3. Accelerated flight position tested with R-Series Speedarms fabric.

Results

After analysis of more than 500 wind tunnel tests, it was concluded that one of the fabrics offers a substantial aerodynamic improvement when used on the speedarms sleeves. In other words, the use of Niviuk's new Aero Speedarms instead of the current R-Series Speedarms allows up to 25% improvement of the pilot's aerodynamic performance. This clear and maximal improvement can be found to a greater extent within the paragliding flight range compared to the fabric used in the sleeves of the current R-Series Speedarms and the other embossed fabrics tested (Fig. 4). It was also found that the Aero Speedarms always performed better than the R-Series Speedarms for all the conditions tested.

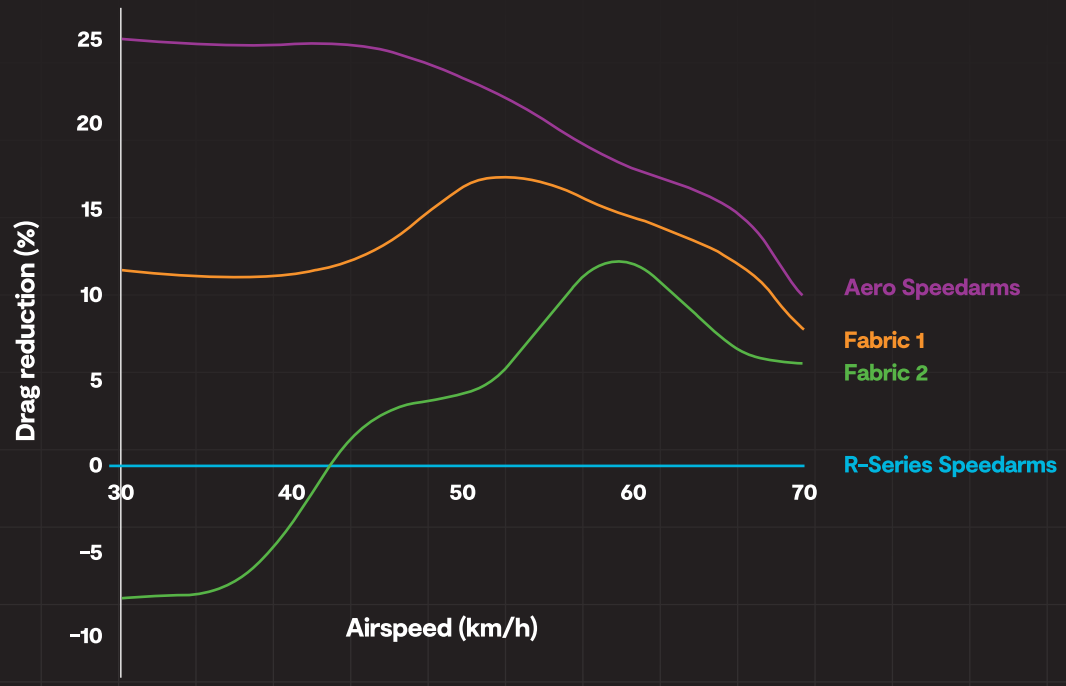

Figure 4. Evolution of the reduction of the aerodynamic drag generated by the arm in accelerated flight position (Fig. 3) as a function of air speed, for the different fabrics analysed. The R-Series Speedarms fabric is used as a reference for comparison.

Additionally, to ensure that the seams did not reduce this improvement in aerodynamic performance, experiments were carried out where the seam was placed in the usual position for this type of sportswear (Fig. 5.a), i.e. completely exposed to the wind; and in a modified position, completely covered from the incident wind (Fig. 5.b). As evidenced by Fig. 6, no noticeable differences can be seen in the wind tunnel tests, as the result is independent of the position of the seam. Thus, the improvement in aerodynamic performance is maintained for the whole flight range studied. It is therefore concluded that the position of the stitching in both positions studied has no influence on the improved aerodynamic performance achieved by using the Aero Speedarms fabric.

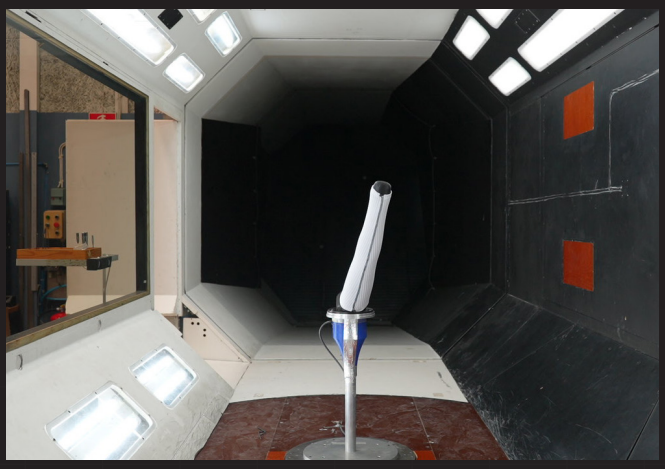

Figure 5.a Seam in usual position, exposed to the incident wind.

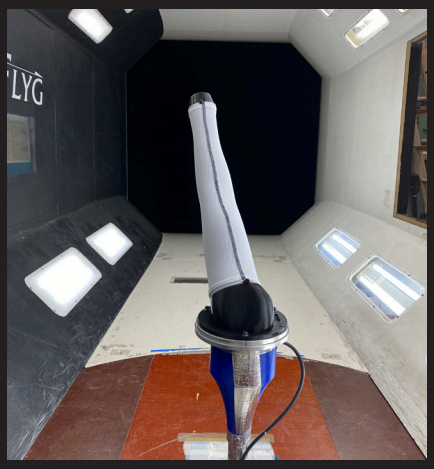

Figure 5.b Seam in usual position, exposed to the incident wind.

Figure 5. Test carried out to study the effect of the position of the seams on the aerodynamic performance of the Aero Speedarms fabric. Full-scale models of human arms are placed in accelerated flight position (as in Fig. 3), applying a simplification of the hand area.

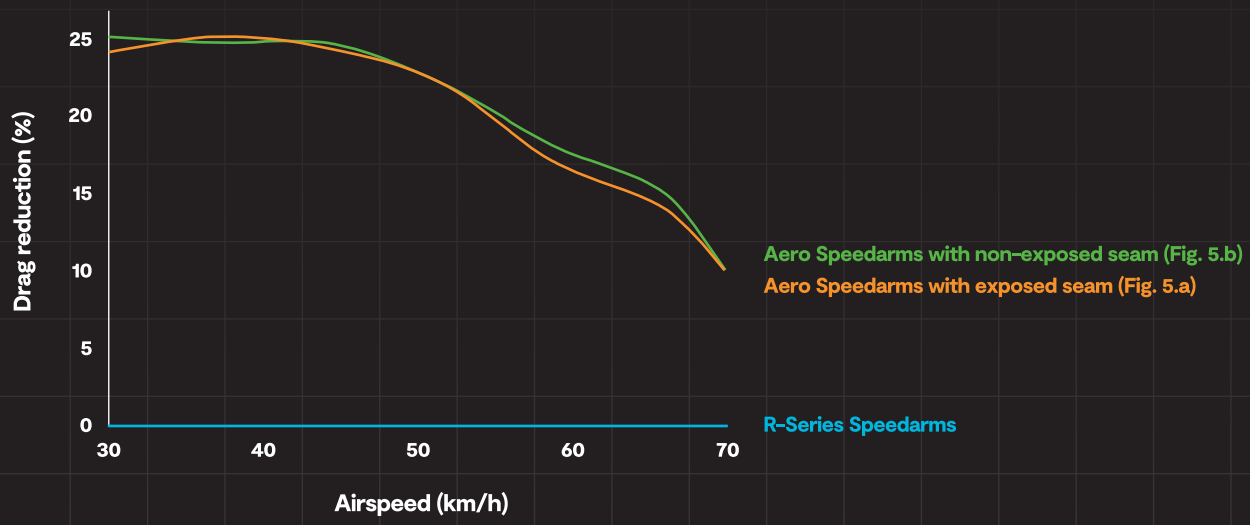

Figure 6. Evolution of the reduction of the aerodynamic friction generated by the arm as a function of air speed. The influence of the position of the seams on the Aero Speedarms fabric is studied in comparison with the reference R-Series Speedarms fabric. "Exposed seam" refers to the position of the seam in Fig. 5.a, fully exposed to the incident wind, while "non-exposed seam" refers to the position of the seam in Fig. 5.b, not exposed to the wind.

Conclusions

Niviuk, aware of the improvement in glide performance that can be achieved by improving the aerodynamic performance of the pilot's arms, invested in the development and wind tunnel testing of new fabrics for the Aero Speedarms. More than 500 tests in the wind tunnel at KTH University in Stockholm, Sweden, were carried out with different full-scale arm models. The tests consisted of varying the fabrics and the position of the arms, under different wind angles and at different airspeeds, and. The resulting aerodynamic forces were computed for each particular scenario.

The study concluded that the use of one of the fabrics that has been specifically developed to make the sleeves of the new Aero Speedarms can improve the aerodynamic performance of the pilot's arms by up to 25% over the full speed range. On average, for the selected fabric and the different arm and flow positions, we can see an average reduction of 18%. In addition, over the full speed range and conditions studied, the Aero Speedarms fabric has always performed better than the R-Series Speedarms fabric. Niviuk has therefore decided to introduce the new Aero Speedarms equipped with this innovative fabric, providing pilots with useful tools to improve their aerodynamic performance. This innovation is in line with Niviuk's philosophy, which seeks to go beyond simple gliding by offering advanced solutions that enhance the paraglider pilot's experience and performance.