ACCIDENT

Aircraft Type and Registration:	Snowbird Mk IV, G-MVOJ
No & Type of Engines:	1 Rotax 582/48-2V piston engine
Year of Manufacture:	1989 (Serial no: SB-019)
Date & Time (UTC):	22 June 2019 at 0925 hrs
Location:	Bedlands Gate, Newby, Cumbria
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Nose structure and engine displaced, right wing leading edge misshapen and front spar bent
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	87 years
Commander's Flying Experience:	363 hours (of which 289 were on type) Last 90 days - 0 hours Last 28 days - 0 hours
Information Source:	AAIB Field Investigation

Synopsis

Following a period of maintenance during which the aircraft fabric covering had been replaced, the pilot was carrying out a ground run and taxi test. During taxi the pilot heard a rattle and decided to try to identify its source and so taxied the aircraft at higher speed. To his surprise, the aircraft became airborne but right wing low. Despite his attempts, he could not prevent the aircraft from flying a continuous turn to the right. The aircraft hit a tree and then struck the ground, still right wing low, before 'pole vaulting' over a dry-stone wall. The aircraft came to rest approximately where it had started the taxi. The pilot suffered serious injuries but has since recovered. The tendency for the aircraft to continuously roll right was probably caused by a slight change in the angle of attack of the outer section of the left wing due to a pair of flying wires being overly tight. The lift created by this condition was greater than the left roll control spoiler could counteract.

History of the flight

The pilot had just completed some restoration work on the aircraft which included replacing the aircraft skin and repainting it. He intended to run the aircraft engine and then to complete some taxi testing.

Having run the aircraft engine without issue, the pilot taxied the aircraft onto the airfield. As he taxied around the airfield, he could hear what he described as a "little rattle". He decided that he would need to taxi the aircraft at a higher speed down the runway in order to try and isolate the source of the noise.

The pilot taxied onto the runway and began to accelerate for his high-speed run. He was surprised when he felt the aircraft become airborne at around 45 kt which he thought was significantly below the normal speed for lift off. As it lifted off, the pilot heard a sound which he described as a "ping" and the aircraft immediately began to roll right. The pilot was concerned that the right wingtip would hit the ground so, whilst he applied opposite stick to the roll, he decided to leave the power set, hoping that the aircraft would climb. He felt that even the application of full opposite stick did not alter the angle of bank to the right. Witnesses describe the aircraft lifting off and immediately banking to the right. The aircraft was then seen to climb, still turning to the right. It flew a continuous right turn through approximately 270° to the west of the airfield before it struck the top of a group of trees. The estimated flight path from witness statements is shown in Figure 1.

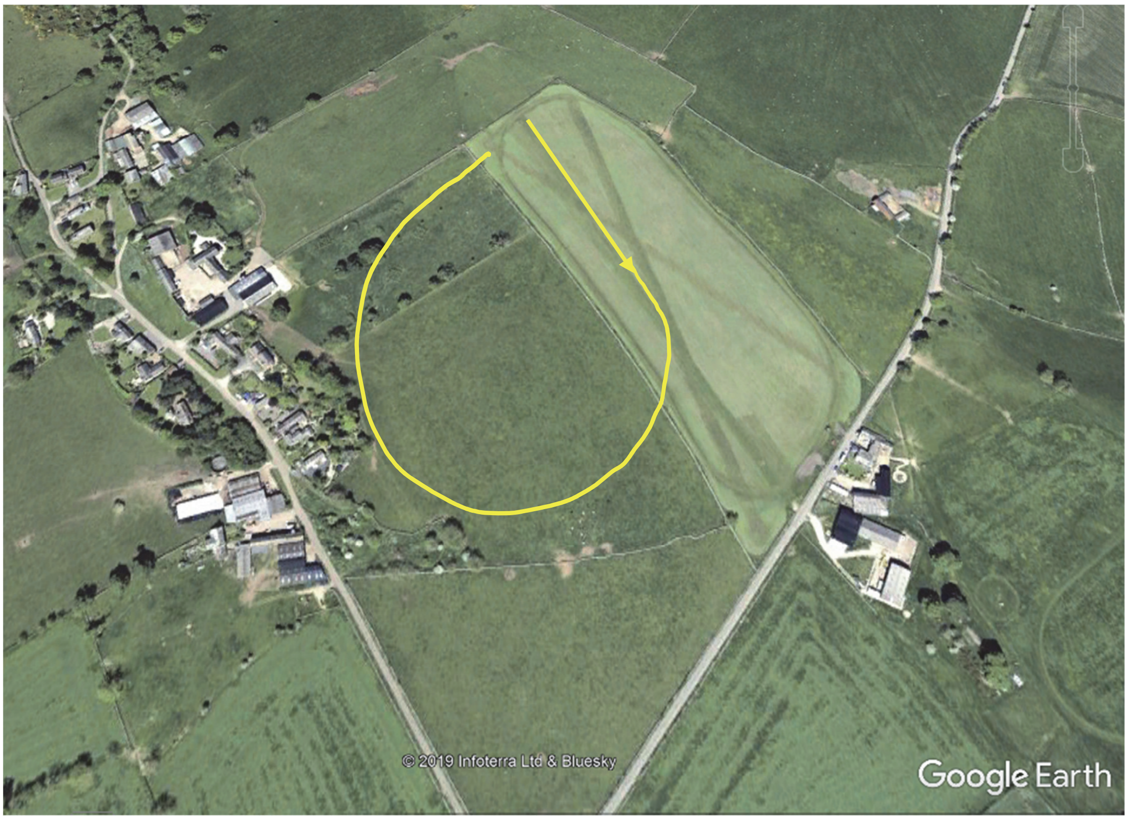

Figure 1
Estimated flight path of G-MVOJ

The aircraft then descended, striking the ground and a dry-stone wall next to the airfield. The aircraft came to rest, on the airfield side of the wall (Figure 2). The pilot was seriously injured.

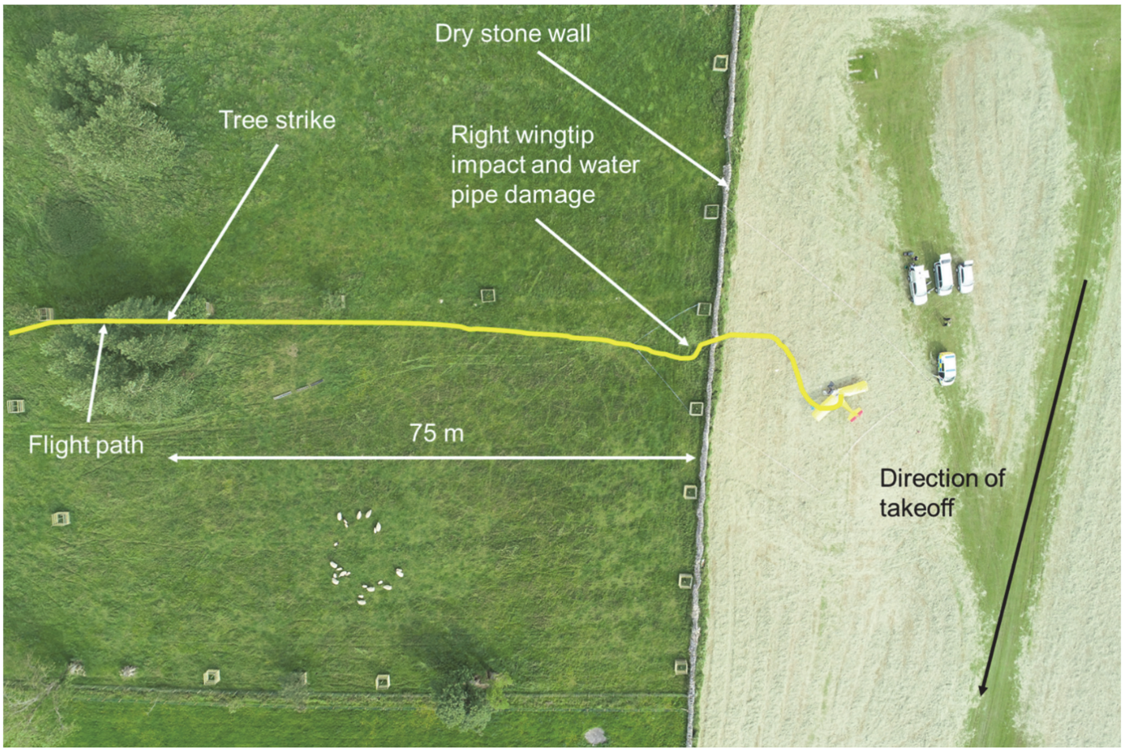

Figure 2

Final aircraft flight path and impact points[1]

Weather information

Weather information was gathered from witnesses, the pilot and a limited recording capability at the airfield. The wind was from 170° at around 10 kt, there was little if any cloud and the temperature was 17°C. The QNH was 1020 hPa.

Accident site

The aircraft had flown a large right arc and was heading back towards the airfield on a track perpendicular to the runway. Whilst airborne and outside the airfield boundary the aircraft hit the top of a poplar tree at a height of approximately 30 ft. A 6 ft long branch was found at the base of the tree, and leaves and twigs had been caught between the aircraft radiator and its fairing.

The aircraft continued to descend, and its right wingtip contacted the ground just in front of the dry-stone wall which forms the airfield boundary. By chance, as the wingtip dug into the soil, part of the tubular wingtip frame broke away and passed through a one-inch diameter polypropylene water pipe buried in the ground alongside the base of the wall. The wingtip digging in caused the aircraft to 'pole-vault' over the wall during which it became entangled

Footnote

[1] At the time that the aircraft took off, the prepared grass runway strip was more clearly defined. Hay making operations were underway and the grass cuttings had been spread for drying. The runway conditions had no bearing on the accident and the AAIB gave permission for hay baling to continue outside of a small cordon placed around the aircraft.

in a single strand barbed wire fence, dragging it and its posts over the wall. Marks on the leading edge of the right wing and stones that dislodged as it hit the wall, suggest that the aircraft was at a 45° angle of right bank.

Now within the airfield boundary, the aircraft hit the ground on the right side of its nose which displaced the engine and caused significant distortion to the right side of the cockpit. The aircraft bounced, rotated about its nose and came to rest upright facing the direction from which it came. Both propeller blades had broken off from their roots and there was a loss of coolant. The right wing, although still attached, had been bent rearwards during the impact sequence. There was no fuel or oil spillage. Figure 3 shows the aircraft at the accident site.

Figure 3
Aircraft accident site

Apart from the distortion to the front and right of the cockpit and instrument panel, the rest of the cockpit and space to the rear were remarkably intact although the lightly-constructed cabin doors had detached. The pilot had been sitting in the left seat and was wearing a four-point harness. The lap strap was undone during the rescue operation, but the narrow shoulder straps had failed.

Aircraft description

The aircraft is a high-wing three-axis two seat microlight aircraft. It has an aluminium box section framework with a synthetic fabric covering with transparencies around the rear of the cockpit. The aircraft is powered by a Rotax 582 two-stroke piston engine driving a twin-blade fixed-pitch propeller. The wing structure consists of fabricated aluminium alloy front and rear spars with ribs attached by dry-riveted joints.

The wings are fitted to the fuselage structure using bolts through the front and rear spars. The spars are braced by tubular struts bolted to the lower edge of the fuselage under the wing. There are also two wire cables, known as flying wires, attached to the lower end of each strut. They extend outwards to where they are attached to eye plates, fixed to the rear spar, a third and two thirds the way along on the underside of the wing. Figure 4 shows the flying wires and the bracing strut under the left wing.

Figure 4

Flying wires and the bracing strut under the left wing
(The blue rope was attached after the accident to stabilise the aircraft)

The aircraft is fitted with conventional rudder and elevator controls and the elevator has an electrically-operated trim tab. There is a small trim tab position indicator in the cockpit alongside the pitch trim switch.

Roll is controlled by a spoiler on the upper surface of each wing. The spoilers are connected to the control stick by rods, levers and cables. When the stick is moved to the left or right to roll the aircraft, the relevant spoiler extends up from the wing surface against spring pressure provided by an elastic bungee. If a left roll is required, the left spoiler extends, lift on the left wing is reduced and the aircraft rolls to the left. When the stick is relaxed and brought back to the mid position the spoiler is closed by the bungee. The right spoiler operates in the same manner for a roll to the right. The design of the system is such that when one of the spoilers extends, the cable to the opposite spoiler slackens and that spoiler is held closed solely by tension in the elastic bungee.

The seats consist of simple crossbars supporting a fabric ‘hammock’ which creates the seat squab and back. The aircraft is fitted with safety straps which consist of a lap strap and two narrow shoulder straps. The shoulder straps are formed by a loop of material passing through rectangular slot plates mounted on a cross frame at the rear of the cockpit above and behind the pilot and passenger’s seat. The shoulder straps equal length either side of the slotted plate is maintained by stitches across both parts of the strap. The shoulder strap lower ends are attached to the left and right parts of the lap strap and are tightened by a sliding buckle assembly on each side.

Aircraft maintenance history

The owner did all the maintenance on the aircraft with appropriate oversight by a British Microlight Aircraft Association (BMAA) inspector. The owner had recently replaced the fabric covering on the aircraft. During this work the pilot described that he had put a “loop” or a “knot” with a whipping[2] in one of the spoiler bungees but cannot recall how or whether it was the left or right. He was content with the work he had carried out and therefore was not expecting any problems or issues and explained that he had ground ran and taxied the aircraft to ensure “everything was right”. He had pre-arranged for the BMAA inspector to visit later that day to carry out the final sign off inspection.

Engineering investigation

The aircraft was dismantled at the accident site and recovered to the AAIB facility in Farnborough for further examination. The aircraft structure and components, from the seats rearwards, were mostly intact except for minor scuffs, tears and abrasions. Notwithstanding the impact damage at the front of the aircraft and the right wing, the fabric covering was tight and in excellent overall condition.

The elevator control system had continuity from the stick to the elevator and had a full and free range of movement. The elevator was fitted with a trim tab on the trailing edge of the right side of the elevator. Although its hinge was slightly loose, it was attached correctly to its electric actuator and was set at an angle 13° downwards. The rudder bar was jammed due to distortion of the cockpit floor, but the cables were intact and, when disconnected from the rudder bar, also gave a full and free range of movement.

On first examination, the stick could not be moved laterally and appeared to be jammed. Closer inspection found that, during the impact sequence, a bell crank inside the fuselage adjacent to the right wing root, had rotated over-centre and become geometrically locked. Once released, the spoilers operated in the correct sense and had a full and free range of movement up to their restrainer cable stop limit. The bungee spring system on each spoiler was examined and both left and right bungees were attached to their respective hooks and eyes. In both cases, a single piece of bungee cord was used but the left bungee was knotted at its ends (thus forming a continuous loop) whereas, for the right bungee, each end had been folded back and whipped to make a small loop around a hook and its ends were covered. Both bungee cords appeared to be of the same material. Figures 5 and 6 show the left and right bungees under the spoilers.

Footnote

[2] Twine wrapped tightly around rope ends to splice them together or to prevent rope ends from fraying.

Figure 5
Left spoiler looped bungee cord

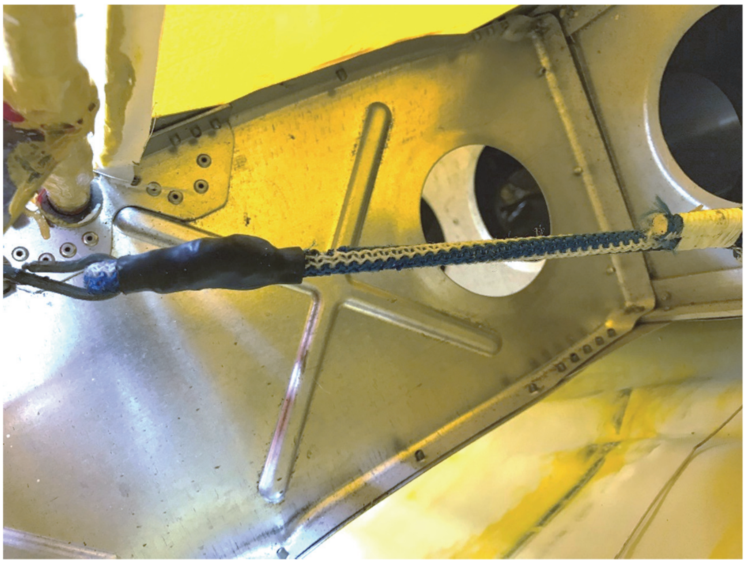

Figure 6
Right spoiler whipped bungee cord

As the methods of installation were different, pull-off checks were carried out on each spoiler by extending them to 250 mm between the spoiler trailing edge and the wing surface. The right spoiler required a 1,325 g force to extend and the left spoiler only required a 675 g force. Similar differences were also found when an operating force was applied to the cables linked to the spoilers within the wings.

At the accident site, both wing struts had been disconnected from the fuselage by removing the attachment bolt, along with the smaller strut braces, and allowed to settle down against the wing for transport. It was noted that the left lower bracing strut joint bolt was more difficult to remove than expected, considering the lightness in construction of the aircraft.

Subsequent examination of the left strut also found that it had a slight permanent curvature along its length whilst the right strut was straight.

The flying wires were not disconnected from the struts or their spar attachments at the accident site. On later examination, it was noted that the right wing flying wires, in their relaxed state, were slack and in good condition. However, the two left wing flying wires were very different in their relaxed condition. They both had multiple tight loop twists and kinks indicating that they had been 'wound up' at some point during assembly. In the absence of tension, the wind-up had released and, because they are restrained at each end, twist loops were formed. The eye plates on which the cables were fitted had not been undone and were still attached correctly. It was also noted that the left pair of cables were made from galvanised steel and the right pair of cables were made from stainless steel. Figures 7 and 8 shows the wind-up twisting and kinks on the left flying wires, compared the right flying wires shown in Figure 9.

Figure 7

Left wing flying wire distortion

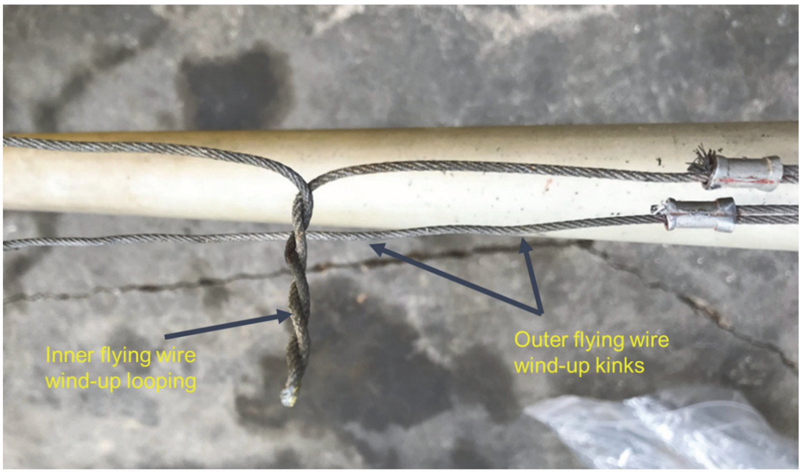

Figure 8

Close up of the distortion to the left inner and outer flying wires.
In addition to the kinks, the outer wire also showed identical wind-up looping further along the cable (out of shot)

Figure 9

Right wing flying wires

Damage to both propeller blades indicated the engine was producing power when the aircraft hit the ground. Subsequent examination of the engine's fuel, ignition and lubrication systems revealed no anomalies. Although the throttle cable was damaged and had been distorted in the accident, it was correctly attached to the carburettors and had a full and free range of movement.

Some of the instruments had been displaced from the instrument panel but were otherwise intact and, when tested, worked correctly; the barometric altimeter was set to 990 hPa (QFE). Apart from a personal camera, which contained nothing relevant to the accident, there were no recording devices on the aircraft.

The seats were undamaged, but the left safety harness shoulder strap had parted. The straps were made from a synthetic canvas-like material and were approximately 25 mm wide. The tapered nature of the strap parting suggests a tensile overload failure. The stitching near the slotted plate had parted. Tapering at the point of failure suggests a severe pull to the right whilst in the slotted plate and the strap failing as it was pulled tight against the edge and corner of its slot. The right pull is consistent with the forces exerted on the pilot during the accident sequence. The lap strap and buckle were undamaged.

Discussions with the pilot

Despite the severity of his injuries, the pilot made a good recovery and was able to describe the events leading up to the accident and up until the point that the aircraft hit "the big tree next to the airfield". He was somewhat surprised when he was informed of his actual trajectory and of which tree he had eventually hit. He described how his aircraft "just hopped off the ground at 40 to 45 kt, much slower than the normal 50 kt" and then of his fear that the right wingtip would touch the ground and cartwheel the aircraft. He also described that he had to pull the stick all the way over to the left and, even with full stick and rudder, could not stop the aircraft turning to the right.

The aircraft was fitted with an electric pitch trim tab and the pilot stated that the trim setting was not adjusted prior to the taxi. He also advised that he very rarely altered the trim because where it was set was suitable for all conditions of flight.

Regarding the work he had done to the aircraft, as well as describing the new fabric coverings and the need to tighten the spoiler bungee, he also mentioned that he had put twists into the flying wires to "keep everything nice and taut".

Additional information

There are very few of this aircraft type still in flying condition and few light aircraft types use upper wing surface spoilers for roll control. There is a rudimentary maintenance manual for the Snowbird Mk IV which includes a list of inspections to be carried out on the control systems. There are some details of the inspection requirements for the spoilers, but there is no mention of the bungee or spring tension required nor of any inspection of the bungees for condition or correct assembly.

The pilot described the aircraft as usually very stable in flight. The pilot's operating handbook (POH) gives the Snowbird Mk IV stall speed at Maximum All Up Weight as 38 mph (33.7 kt) and a lift off speed of 42 mph (37.3 kt). These figures correlate well with the records of G-MVOJ's flight test that was conducted in September 2018.

Anecdotal evidence suggests that the Snowbird is sensitive to alterations in its lateral centre of gravity, ie when flown by a single pilot. If there is only one occupant sitting in the left seat, the lateral imbalance must be countered using a small amount of constantly applied left spoiler. This has two disadvantages; the roll range is reduced, and asymmetric drag is increased, leading to aircraft yaw which must be corrected with the rudder. To alleviate this, owners have often tightened the flying wires which changes the wing form and slightly increases the lift produced by the left wing.

Anecdotal evidence also suggests that this is done by twisting the flying wires in the same direction as the lay (twist) of the strands, this increases the pitch of the helix created by the lay of strands, thus shortening the wires to increase their tension. This method is used in the absence of turnbuckle assemblies. However, this is not an ideal practice and may compromise any factor of safety inherent in a multi-strand wire by introducing bends or kinks as seen in Figures 7 and 8.

Again, the aircraft maintenance manual makes no mention of the tension required to be pre-set in the flying wires.

Analysis

The pilot described a "ping" coincident with the aircraft becoming airborne. The examination of the aircraft found nothing that was broken or had been damaged prior to the accident. All the damage to the aircraft could be attributed to the various stages of the accident sequence and there was no evidence of a problem with the power output and controllability of the engine.

At the accident site it could be seen that the left side of the fuselage bracing strut and wing spar mounts were undamaged. However, it was noted that the flying wires seemed particularly tight and this manifested itself in the difficulty experienced extracting the bracing strut lower bolt. After the left wing was removed, the phenomenon of the flying wires twisting up in their relaxed state shows that they were under additional tension as the pilot had described.

Unintentional takeoff

The pilot was surprised at what he thought was the lower than normal speed at which the aircraft became airborne, stating that it was at 40 to 45 kt, as indicated on the airspeed indicator. However, when the figures given by the POH are taken into consideration, taking off at that speed with one person onboard was reasonably normal.

From the description by the pilot and witnesses, the constant right turn flight path shows that more lift was being created by the left wing than the right. So much so, that despite the pilot applying full left roll input on the stick, the aircraft continued to fly to the right.

In the absence of an aileron, for the left wing to create more lift, the airspeed over the wings, the wing shape and angle of attack were considered.

The conditions on the day were benign; a clear day with a wind of 170° at 10 kt resulting in an insignificant crosswind. From this it can be concluded that there was very little, if any, difference in airspeed over the left and right wings.

The pilot had flown many hours in this aircraft without incident and, other than the replacement of the covering which necessitated the temporary removal of the flying wires, no recent maintenance had been carried out on the wing structure. A dimensional check at the wing roots showed no measurable difference.

Influence of the flying wires

It is likely that the increased tension in the left flying wires due to the twists introduced by the pilot had an effect. In particular, the inner flying wire (acting on the rear spar) was very tight as was the outer flying wire which acted on the spar towards its outboard end. This is likely to have caused the structure to flex downwards very slightly, creating a wing wash-in effect. This would result in a slightly increased angle of attack, and hence increased lift, at the mid to outer section of the wing; a location at which the extra lift would have the most significant effect due to the greater moment arm.

Consideration was given to whether the spoiler bungee tension was a factor in the difficulty the pilot had in controlling the aircraft once airborne. The spoiler bungee tension required is not specified. With no tension, there could be a tendency for the spoiler to lift at higher airspeeds as the negative pressure above the wing increases. How far it might lift or at what airspeed is not known. On G-MVOJ, both spoiler bungees were in tension, albeit the right one was about twice that of the left. The pilot applied full left stick as he was trying to roll the aircraft left and so lift the left, lower tensioned spoiler. The higher tensioned right spoiler is likely to have remained flush with the wing surface. Therefore, it is considered that the difference in tension between the two spoiler bungees was not a factor in this accident.

The rattle and later "ping" sound heard or felt by the pilot was not identified. The aircraft examination found nothing obvious that could have created the sound. As the aircraft became airborne and tension in the flying wires increased, differences in internal structural tension created by the new and taut fabric covering may have caused one of the many dry-riveted joints to have flexed or creaked. The sound could have been amplified sufficiently by the 'drum tightness' of the fabric covering to be heard by the pilot.

Conclusion

During a high-speed taxi run, the aircraft became airborne unintentionally and, thereafter, became established in a continuous right turn which could not be controlled by the pilot. This was due to an increase in the lift produced by the left wing which was greater than could be countered by the roll spoiler. The increased lift was likely to have been the result of a slight change in the shape of the mid to outer section of the left wing caused by overly tight flying wires.

Published: 31 October 2019.