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Aircraft Type and Registration:	Cyclone AX3, G-BUTC
No. and Type of Engines:	One, Rotax 618
Aircraft Serial Number:	PFA 245-12365
Year of Manufacture:	1993
Date and Time (UTC):	16 May 1998, 1500 hrs
Location:	Cushenstown, New Ross, Co. Wexford
Type of Flight:	Private
Persons on Board:	Crew - 1 Passenger - 1
Injuries:	Crew - None Passenger - None
Nature of Damage:	Extensive damage to RH wing, cockpit area, nose wheel/LH wheel broken off, main tubular structure fractured.
Commanders Licence:	Private Pilots Licence (Aeroplane)
Commanders Age:	42 years
Commanders Flying Experience:	90 hours (of which 8 were on type)
Information Source:	Pilot reported accident. AAIU Field Investigation.

Synopsis

G-BUTC departed Waterford Airport on a short x-country flight to the New Ross area. The pilot intended carrying out a touch and go landing on a private airstrip at Donanore near New Ross.

After a flight of one hours duration, and at about 800 feet while lining up with the runway to land, the aircraft went into an uncommanded left spiral dive from which the pilot recovered. He climbed back to 1,000 feet and, on reducing power, the aircraft again went into a left spiral dive from which he recovered. At this stage he had moved somewhat southwards away from his original intended landing area and, as he reduced power again the aircraft spiralled to the left and landed heavily in a nose down attitude in a field of barley.

The aircraft was extensively damaged. Ground indications showed that the aircraft had run on for approximately 12 feet and then came to a rest in a nose down attitude but with the nosewheel and LH main undercarriage torn off. There was no fire. The pilot and passenger vacated the aircraft unassisted. There were no injuries reported.

The weather forecast obtained by the pilot from Waterford Airport gave the wind direction and speed as 180/06 kt, with visibility of less than 10 km in slight haze.

Description of the Aircraft

The AX3 is a high wing microlight design, with full three axis control. The design is a development of an earlier two axis control model. The general layout is shown in Annex A.

In the following description, the bracketed numbers refer to the component identification numbers in Annex A, which is a extract from the aircraft manual.

The wing structure consists of two round aluminium spars, one (1) of which forms the leading edge and the other (3) forms the trailing edge. Lift loads are carried by two wing lift struts (25, 27), which attach to both spars at a point located at 65% of span.

The wings do not contain conventional ribs. The spars are separated by two compression struts (5). The wing structure is braced by two diagonal wing cables (6). These run from the wing root to either end of the outer compression strut (5), which is located where the wing lift struts meet the spars. These cables are manufactured to a fixed length and are not fitted with adjustable turnbuckles. The tips of the spars are separated by a wing tip tube (2).

This wing tip tube (2) is a light push-fit into end fittings on the spars. The spar end fittings are aluminium blocks which are riveted to the spars, each by two aluminium pop rivets. The wing is covered with a synthetic woven material, in the form of a single envelope. The envelope covers the entire top surface and approximately 2/3 of the lower surface as measured inboard from the wing tip. This envelope is fitted by sliding over the tips is then pulled up to the wing root. The envelope is then tightened in position by wing top-surface batons (29), which span between the two spars.

Torsional stiffness of the wing is provided by a combination of the following components. They are listed in order of their contribution to the stiffness:-

- wing lift struts (25 & 27) and jury struts (26 and 28)
- drag and landing wing cables (6)
- tensioned wing covering envelope
- wing tip tube (2).

Outboard of the outer compression strut (5), the wing stiffness is maintained by:-

- stiffness of the spar end cantilever
- tensioned wing covering using cabling envelope
- wing tip tube.

History of the Aircraft

This aircraft was privately assembled in 1993, from a kit provided by the manufacturers. It was originally fitted with a Rotax 582 engine. However, after 3 months and 47 hours flying, it was fitted with a more powerful Rotax 618 engine. It is believed that this aircraft is an unique combination of this airframe and engine.

The aircraft was five years old, but had only flown 112 hours up to the time of the accident.

Wreckage Information

The aircraft suffered extensive damage to the nose area. The cockpit nose fairing support structure and the structure supporting the rudder pedals, flight controls and nose wheel was extensively compressed. The propeller was shattered and the engine mount distorted. The fuselage structure had arched aft of the cockpit. The right wing tip leading edge had impacted on the ground, and left a significant witness mark on the ground. This mark was deep towards the wing tip. The wing tip area of the covering envelope was torn open, and the wing tip tube (2) had jumped out of position and was lying on the ground.

The drag wing cable, i.e., the cable spanning between the forward wing root and the rear point of the outer compression strut, was found to be slack. Further examination showed that this wing was permanently elongated by 2.5 cm.

The outer 3 feet of the right wing spar leading edge was stained by clay. This length corresponded to the ground impact mark.

Further examination revealed that the two rivets which secured the aluminium fitted in the rear spar of the right wing, had disappeared, allowing the fitting to rotate in the spar. The effect of such rotation would increase the pitch angle of the wing tip tube, and to increase the angle of attack of the tip section of the wing.

A witness mark on the rear spar, made by the wing tip tube, indicates that the angle of attack of the tip area of the wing was approximately 11° above normal at the time of impact. Inspection of the rear spar end fitting also indicated that the fitting had been working in the rear spar, i.e. it had rotated through a small arc, a number of times, in the spar.

The leading edge spar tube was bent rearwards, about 5 cm at the tip. The bend was centred at the point where the outer compression strut met the spar. There was no vertical component in this bend.

Examination of the torn fabric of the envelope wing tip showed indications that the fabric had flayed for a period, during the flight. The tearing appears progressive, rather than a single event overload. The damage was consistent with the fabric tearing in flight and flapping in the airflow for a short time.

Other Information

The manufacturers of the aircraft supplied details of tests carried out on the standard AX3, with a view to exploring its aero-towing capabilities. These tests include flight tests with load cells on the drag wing cables. These tests indicate the loads on these cables, even in manoeuvring operations, were well below the structured limits of the cables.

It was not easy to visually determine that the cable was slack, as it is external to the wing fabric to the inner section of its run and internal to the fabric of its outer section. In the slack condition, the cable was supported by the fabric, thereby making visual detection of its slackness somewhat difficult.

The spar end fitting which supports the wing end rib, and is located in the rear spar end, and the rivets which secure this fitting, are not covered by the wing fabric envelope, as cut-outs are made in the fabric to facilitate inspection of these items.

Rivets on the undamaged left wing rear spar end fitting were found to be not well formed.

The aircraft operated and hangered near the coast, which would increase corrosion problems in rivets.

Information from the Pilot

The pilot stated that he had experienced three separate uncontrolled rolls to the left. He reported indicated airspeeds in excess of 70 mph were encountered during these events. He also reported that the slip ball was at its right limit stop during these spirals which would have induced an airspeed reading error. It is therefore possible that the actual airspeed during these events was considerably higher. The maximum manoeuvring speed, Va, for this aircraft is 62 mph.

The pilot stated that he had not encountered turbulence during the flight.

Tests and Experiences

The wing was examined with the wing covering envelope and wing tip tube removed. From both wings, it was noted that the right wing exhibited much lower torsional stiffness than the left wing. When the elongated drag wing cable of the right wing was replaced by the undamaged cable of the left wing, the stiffness of the right wing was restored to that of the undamaged left wing.

Analysis

The wreckage and ground marks indicate that the aircraft struck the ground in a steep nose down attitude. The right wing also struck the ground, with an impact load in line with the wing chord line.

The uncommanded rolls to the left are consistent with an increase in the angle of attack of the right wing tip area. The witness marks on the right rear spar indicate that the tip area of the right wing had an angle of attack of 11° more than normal at the time of impact. It was impossible to determine if the elongation of the right wing drag wing cable was due to pre-existing damage or overload, or as a result of the impact of the right wing tip with the ground in the accident.

Corrosion marks surrounding the rivet holes on the rear spar tip where the end fitting was secured, indicates that the rivets were in place at some stage. The lack of shear marks on the spar or fitting, and the absence of rivet debris in the spar indicates that the rivets did not shear, either in service or in the crash, but rather they became loose and fell out at some stage.

There was difficulty in separating any pre-impact defects in the right wing from the damage suffered by the wing in the final impact. However, the most likely sequence of events is that the rivets in the right wing rear spar end fitting became loose, in service, and fell out. This permitted torsional flexing of the wing section outboard of the outer compression strut. This flexing ultimately lead to a fatigue failure in the fabric in the wing tip area.

The loss of two components which contributed to torsional stiffness of the wing area resulted in loss of torsional stiffness, which caused the pitch angle of the wing tip to increase. This would have further increased the load in the tip fabric, leading to rapid progressive failure of the fabric, resulting in further loss of torsional stiffness, and further increased the angle of attack.

This would have resulted in the aircraft performing an uncommanded roll to the left. High speeds and aerodynamics loads in the resultant spiral dive would have caused further overloading of the fabric and further progressive loss of torsional stiffness of the wing, thereby exacerbating the control problems.

While it is probable that the elongation of the drag wing cable was as a result of the wing impact, it is a matter of concern that the pilot was unable to state if the cable was in a slack condition prior to the flights. Visual observation of any cable slackness is complicated by its routing through the wing fabric. The pilot did not posses any device for checking the tension of these cables, and no value for the tension of the cables is given in the aircraft maintenance or construction manuals.

The aircraft had flown successfully for an hour before the first uncommanded roll to the left. This indicated that the wing had sufficient torsional stiffness up to that point of the flight. Consequently it is improbable that the aircraft had suffered any significant damage prior to departure. No physical evidence of such damage was found.

Conclusion

The probable cause of the accident was the loss of lateral control, due to loss of torsional stiffness of the right wing, in the wing tip area. The loss of stiffness was probably caused by the loss of the rivets in the rear spar. This resulted in flexing of the wing tip area, which caused the fabric in the tip area to fail causing a progressive critical loss of wing stiffness. The damage was probably exacerbated by the successive spiral dives which resulted from the loss of lateral control.

Safety Recommendations (SR)

1. The aircraft manufacturers should issue a service bulletin informing owners of the possible loss of spar end fittings rivets, and that pre-flight inspections should specifically check for loose or missing rivets in this area, and possible damage to the wing fabric in this area. **(SR 5 of 1999)**

2. The aircraft manufacturers should consider advising owners to replace the aluminium rivets in the spar with monel rivets, particularly when operating in area of high corrosion potential. **(SR 6 of 1999)**

3. The aircraft manufacturers should inform owners of the permissible tension limits in the wing cable, and advise owners on how this tension should be measured on a routine basis. **(SR 7 of 1999)**

ANNEX A

AX3/3 (SHT1)
08.09.92

AIRFRAME COMPONENT NAMES