ACCIDENT

Aircraft Type and Registration:	CAP 231, G-IIHZ	
No & Type of Engines:	1 Lycoming AEIO-540-L1B5D piston engine	
Year of Manufacture:	1988 (Serial no: 8)	
Date & Time (UTC):	9 January 2022 at 1515 hrs	
Location:	Mundesley, Norfolk	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Control arm mount detached from rudder, fin stern post dis-bonded from fin structure	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	51 years	
Commander's Flying Experience:	359 hours (of which 200 were on type) Last 90 days - 11 hours Last 28 days - 5 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries made by the AAIB	

Synopsis

The pilot had taken off from Northrepps Airfield in Norfolk to carry out an aerobatic display sequence practice. During one of the manoeuvres, he felt a "jolt" through the airframe and the aircraft departed into an inverted spin. He was able to regain control of the aircraft and land back on the airfield. Examination of the aircraft found that the plywood mounting structures of the lower hinge assembly of the rudder and fin had failed. The exact cause and sequence of the failure of the various structures could not be determined.

History of the flight

The pilot had taken off from Northrepps Airfield in Norfolk to carry out an aerobatic display sequence practice towards the North Norfolk coast. The pilot had completed several high energy manoeuvres, and as he neared the end of the display sequence and was conducting a vertical left roll, he felt a "jolt" through the aircraft, which immediately departed into an inverted spin. He closed the throttle and realising that there was something odd about the yaw control, he gently recovered the aircraft to level flight using the ailerons. He was able to retain control of the aircraft and carried out an extended long final approach to land back at the airfield. The landing was uneventful.

Examination of the aircraft immediately after the flight found that the rudder control horn had partially broken away from the rudder structure on its left side. There was also dis-bonding

damage towards the bottom of the fin 'stern post'. The small aluminium alloy fairing which forms the leading edge at the bottom of the rudder was also trapped and deformed.

Structural examination

Rudder

The rudder is of wooden construction consisting of a lightweight three ply 2.5 mm thick plywood skin bonded to plywood ribs. The surfaces of the rudder are fabric covered with an epoxy coating. There are three metal pivot hinges attached to plywood re-enforced blocks within a box section plywood main spar. The rudder control horn was attached to the back of the lower hinge plywood re-enforcing block. An aluminium fairing was fitted around the bottom leading edge of the rudder and encloses the hinge area around the control horn. It was held in place by small (No 6 x ½ inch) countersunk wood screws.

The fairing was partially attached but appears to have been trapped and crushed between the rudder fin skin edges where they overlap the stern post (Figure 1).

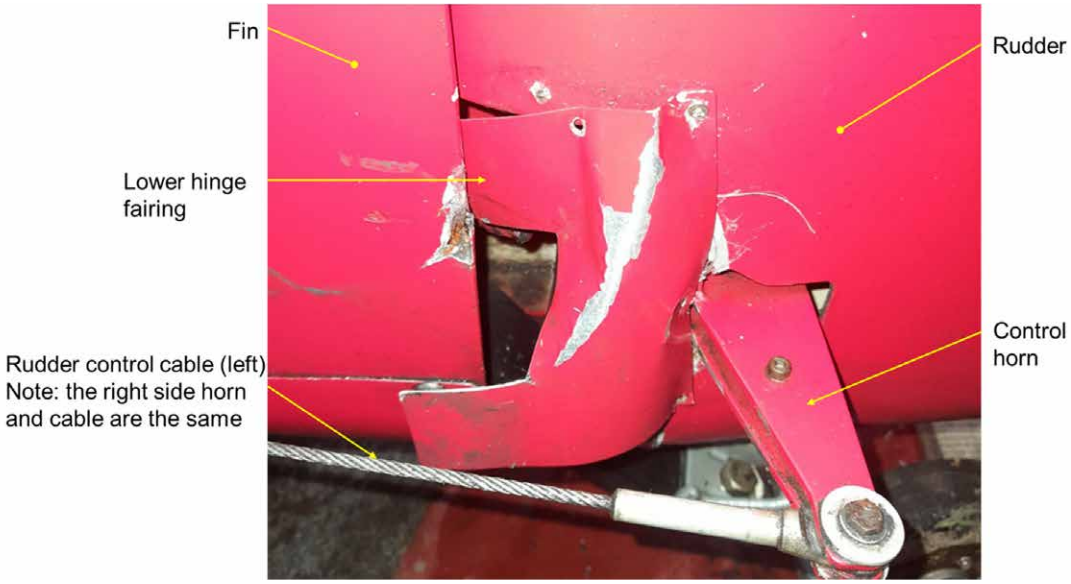

Figure 1

Rudder lower hinge fairing damage

The upper and lower rudder hinge pivot brackets and surrounding structure was undamaged as were the left and right faces of the rudder. The lower hinge and control horn were correctly attached to the re-enforcing block, but this was partially detached from the rudder structure. It had broken away from the box section main spar within the rudder structure (Figure 2).

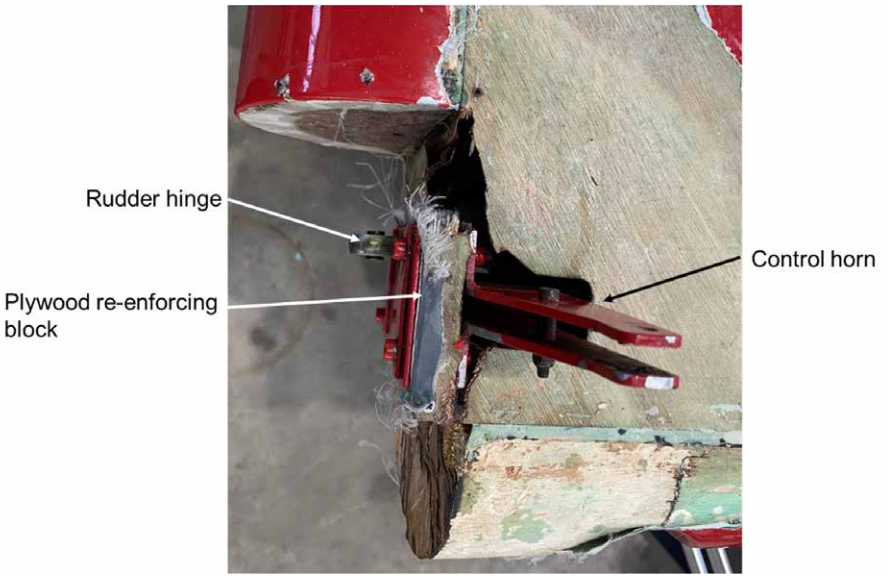

Figure 2

Damage to the rudder spar and lower hinge and horn mounting block (Fabric covering removed from the surrounding area for examination)

Fin

The fin is of similar construction to the rudder. Three hinge pivot brackets are mounted on the rear spar of the fin, described as the stern post. The bottom hinge bracket is fitted with adjustable rudder travel stops. The lower portion of the stern post near the lower hinge bracket, whilst still in its correct position, had dis-bonded from the fin skin structure and lost its rigidity. Evidence of distress on the centre and lower hinge between the stern post and skin overlap is shown in Figures 3 and 4.

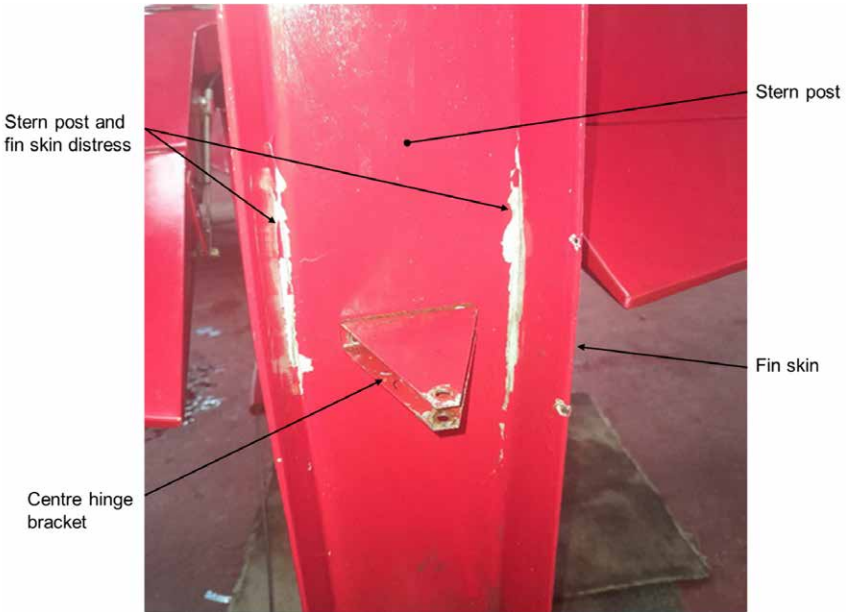

Figure 3

Distress between the fin skin and stern post both sides of the centre hinge

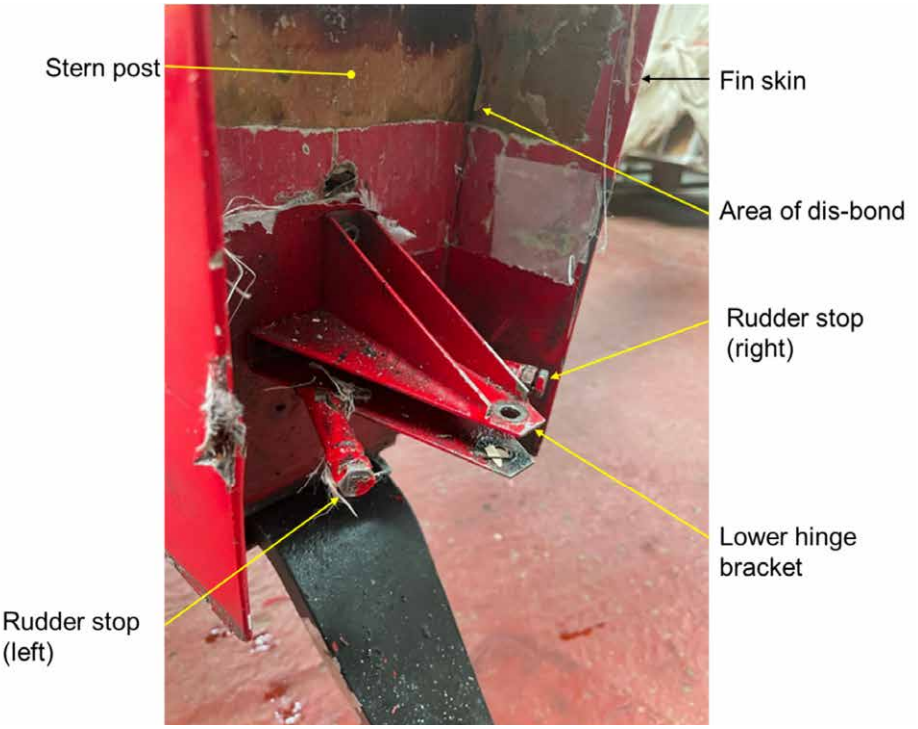

Figure 4

Lower hinge bracket and integrated stops showing the dis-bond.
(Fabric covering removed in the surrounding area for examination)

Examination of the stern post attachment to the fin skins showed evidence that a repair had been carried out in the past and that the right side glued edge had parted. It was also apparent that the bond along this edge seemed to have been assembled with only a small bead of glue.

Discussion

Failure sequence

The nature of the damage to the fin, rudder and fairing made it difficult to ascertain the initiating event. If the rudder horn on its re-enforcing block had partially detached first, it is plausible that it could lead to the fairing damage which in turn led to the stern post damage.

Similarly, the same conclusion could be drawn if the fairing had detached during rudder movement and become jammed between the rudder and stern post. This would result in damage to the bottom hinge and horn block and a transference of more load on to the centre hinge leading to the fin dis-bond.

It is also possible that the stern post had dis-bonded first, which would have led to a loss of rigidity in the lower hinge bracket. This would have put abnormal loads into the centre hinge bracket hence the distress apparent where the skin meets the stern post on both sides. Additionally, this mis-location or loss of rigidity would have led to abnormal loads in the bottom hinge rudder and control horn.

Potential cause

The aircraft was designed to undertake high energy aerobatic flight. A vertical left roll manoeuvre was being flown when the aircraft departed into the inverted spin. This is not considered to have put abnormal loads on the rudder. The pilot was experienced in the manoeuvres he was flying and had done the same routine many times before. Notwithstanding, an overly vigorous input into the rudder control system earlier in the flight, shock loading the control horn or it 'slamming' onto the right control stop, has to be considered. However, discussions with the pilot and his description of his regularly flown routine, suggest that whilst rudder control inputs must be positive, rapid and use the full range of movement, they are not to the extent the stops are constantly being hit excessively hard by the rudder.

The possibility of the rudder being forced onto its stops by mishandling on the ground, in the hangar or due to gusty conditions whilst the aircraft is parked, was considered. However, discussions with the pilot, who is the sole owner of the aircraft, suggest that these potential risks to the rudder are highly unlikely and therefore can be ruled out.

Conclusions

The rudder and fin components failed during part of an aerobatic sequence which had been regularly flown and practiced by the pilot. Until the jolt leading to the inverted spin, the pilot does not consider anything unusual to have occurred, or that any abnormal loads were applied to the rudder.

There appears to be three distinct failure features identified in the rudder and fin components. There is partial detachment and severe distortion to the lower hinge fairing, the horn and lower hinge mounting block has partially broken away and the glued joint between the stern post and fin skin, which was part of a previous repair, had failed. It is plausible that either one of these failures could lead to the others. However, it could not be positively determined which one was the initiating failure.