ACCIDENT

Gyroplane Type and Registration:	Ken Brock KB-2, G-BUYT
No & Type of Engines:	1 Rotax 582 piston engine
Category:	2.3
Year of Manufacture:	1993
Date & Time (UTC):	15 December 2004 at 1410 hrs
Location:	Sutton Bank, Thirsk, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	3,350 hours (of which 33 were on gyroplanes and 12 were on type) Last 90 days -12 hours (0 on type) Last 28 days - 3 hours (0 on type)
Information Source:	AAIB Field Investigation

Synopsis

Shortly after takeoff from a grass strip at Sutton Bank Airfield, the gyroplane developed a nose low attitude and descended over the edge of an escarpment. Its engine noise was heard to reduce and a 'crunch' noise was heard by witnesses as it began its descent. The wreckage of the gyroplane was discovered at the base of the escarpment where the pilot had been fatally injured.

History of flight

The gyroplane had been flown to the Yorkshire Gliding Club's site at Sutton Bank by its co-owner on the morning of the accident. After this 12 minute flight, the gyroplane was shut down and parked outside. During the morning, the pilot had flown one gliding instructional flight and three aero towing flights. After lunch, the co-owner started the gyroplane's engine whilst the pilot prepared himself for his flight, the purpose of which appears to have been to maintain currency. The gyroplane was not refuelled and it is estimated that there was 2.5 gallons of fuel on board. Prior to takeoff, the pilot was observed to check full and free control movement and perform a normal pre-rotate on the rotorblades. A witness also noticed the rotor moved to full aft; the normal position at the start of the take-off roll. The gyroplane took off from the south-westerly grass strip, becoming airborne after approximately 200 m and maintained a very low height for a short period before climbing away. It

appeared that the gyroplane had climbed no higher than 20 ft when its pitch attitude abruptly changed to nose low and it began to descend. There was no sign of any pilot induced oscillation. This descent continued below the upper edge of the escarpment at the end of the grass strip and out of site of witnesses. One witness reported hearing a 'crunch' as the gyroplane began its descent and several witnesses believed they heard the engine noise reduce at about the same time. The gyroplane crashed on a footpath below the escarpment shortly afterwards, fatally injuring the pilot.

Meteorology

An aftercast from the meteorological office indicated that at the time of the accident there was a light north-westerly wind, excellent visibility and little cloud cover. There would have been rising air coming up the face of the escarpment but this was unlikely to have been of sufficient strength to give the pilot handling problems with the gyroplane.

Pathology

The pathological examination of the pilot revealed that he died from multiple injuries. No evidence was found of any disease, alcohol, drugs or toxic substances which could have caused or contributed to the cause of the accident. The pilot weighed in excess of 100 kg.

Accident site

The accident site was located between Roulston and Ivy Scar, which are just on the south-western side of the Yorkshire Gliding Club's airfield which is located on the top of Sutton Bank. The gyroplane had crashed on a footpath approximately 205 ft below and 100 m from the Cleveland Way, a National Trail public footpath which runs along the upper edge of Sutton Bank ridge. The area between the accident site and the almost vertical cliff that leads up to the Cleveland Way is gently sloping undulating land sparsely covered with small to medium sized trees, bushes and rock outcrops. The land in the area to the south and west of the accident site slopes downwards and is densely covered with substantial trees for approximately 1.2 km. Approximately 350 m to the north-west of the accident site and 320 ft below it are open cattle grazing fields.

Impact parameters

The gyroplane's initial impact was with the top of a medium sized tree located approximately 15 m to the east-north-east from where the wreckage finally came to rest. It was not possible to determine, with any degree of confidence, which part of the gyroplane made initial contact with the tree. At the time of this contact, it is estimated that the gyroplane was on a heading of about 250°M, flying at a speed of about 20 mph and descending at around 150 ft per minute. After the initial tree contact, it continued descending on a general heading of 250°M and struck the trunks of two more medium sized trees, which caused major damage to the structure of the gyroplane. It then impacted the ground with a high decent rate, slow forward speed, banked to the right and pitched nose down. The force of this ground impact failed both the lateral and longitudinal beams which, together with the rotor mast, form the main structural elements of the airframe. A small tree was dragged by the tail of the gyroplane, which came to rest on top of the wreckage. All the parts of the gyroplane, except the fixed horizontal stabiliser, were present at the accident site but photographs taken during the takeoff on the accident flight showed that the horizontal stabiliser had not been fitted. Evidence indicated that the propeller was being driven at low power by the engine at the time of the ground impact. The morning following the accident, when the wreckage was examined by the AAIB, there was a smell of fuel around the wreckage, but the seat/fuel tank was empty. This had been ruptured during the ground impact sequence, the rupture being located at the lowest point of the tank in its as found attitude, and hence any fuel contained prior to the accident would have drained away. The fuel cock fitted between the seat/fuel tank and the engine was found to be selected in the ON position.

Wreckage examination

The wreckage was inspected both on-site and at the AAIB facility at Farnborough. Examination of the flying control system found no evidence of disconnections but there was evidence, in the form of witness marks, of a restriction to the motion of the left cyclic control rod, in the area where this rod runs next to the left-hand end of the seat frame support crossbar. This is located at the lower rear edge of the seat, see Figure 1. These marks had the appearance of having recently occurred, but it was not possible to determine if the restriction came about before or during the impact sequence.

The main rotor blades showed that, at impact, they were rotating with low energy and there was no evidence to indicate that they had struck the rear of the gyroplane or the propeller.

The engine was taken to the manufacturer's UK agents facility for examination and testing. External and internal examination showed no evidence of a major failure, disconnect or partial seizure between the pistons and their cylinder bores. Both carburettor bowls contained fuel and, together with the fuel filter, were free of contamination. The engine was installed onto an airframe mounting, a replacement propeller was fitted and a successful engine test run was carried out.

Seat installation, (Figure 1)

The pilot's seat on this gyroplane was a 31.4 ltr (7 imp gallons, 23 kg) capacity Ken Brock seat/fuel tank combination kit, empty weight 4.4 kg, made from a moulded plastic material. The weight of the seat/fuel/pilot is supported by a horizontally mounted U shaped tubular frame bolted, at the rear, to a support crossbar which itself is attached by two bolts to the aluminium alloy square section tube rotor mast. The frame is supported at the front by two simple struts to the longitudinal structural beam. The top of the seat is also attached to the mast by a 16 gauge aluminium alloy bracket, which was supplied with the seat kit, designed to restrain or stabilise the seat in the fore/aft and lateral planes. This bracket does not transmit any significant vertical loads between the seat and the mast. It is secured to the top of the seat back by three bolts, and to a fitting clamped around the mast by two bolts (left and right) through two integral lugs.

The pilot is restrained in the seat by a four point harness. The upper torso restraint is connected to a fitting on the rotor mast, the lap strap, to the seat frame support crossbar.

Seat examination

Examination of the seat revealed that the left side lug of the attachment bracket at the top of the seat, at its connection to the clamp around the mast, had failed by a fatigue cracking mechanism, prior to the first impact with the trees. The right side lug had also partially failed in fatigue and then failed completely in a one-off overload mechanism. It was not possible to determine if the overload failure had occurred before the first impact or during the impact sequence. There was very good evidence of fretting between the attachment bolt washers and both the left and right lugs of the attachment bracket, indicating that there had been relative movement between the attachment bracket and the mast clamp over a period of time. Examination of the seat frame support crossbar, at its attachment to the rotor mast, found it to be loose and able to be 'rocked' laterally. There was very good evidence of fretting of the crossbar steel attachment bolts and ovalisation, in a downward direction, of the bolt holes in the aluminium rotor mast, indicating that this damage had occurred over a period of time. It was also found that the cross section of the hollow square section rotor mast had reduced in the immediate area of the attachment bolt holes, deformation being present on both the front and rear faces, in a manner consistent with excessive torque tightening of these attachment bolts. It was not established when this deformation occurred.

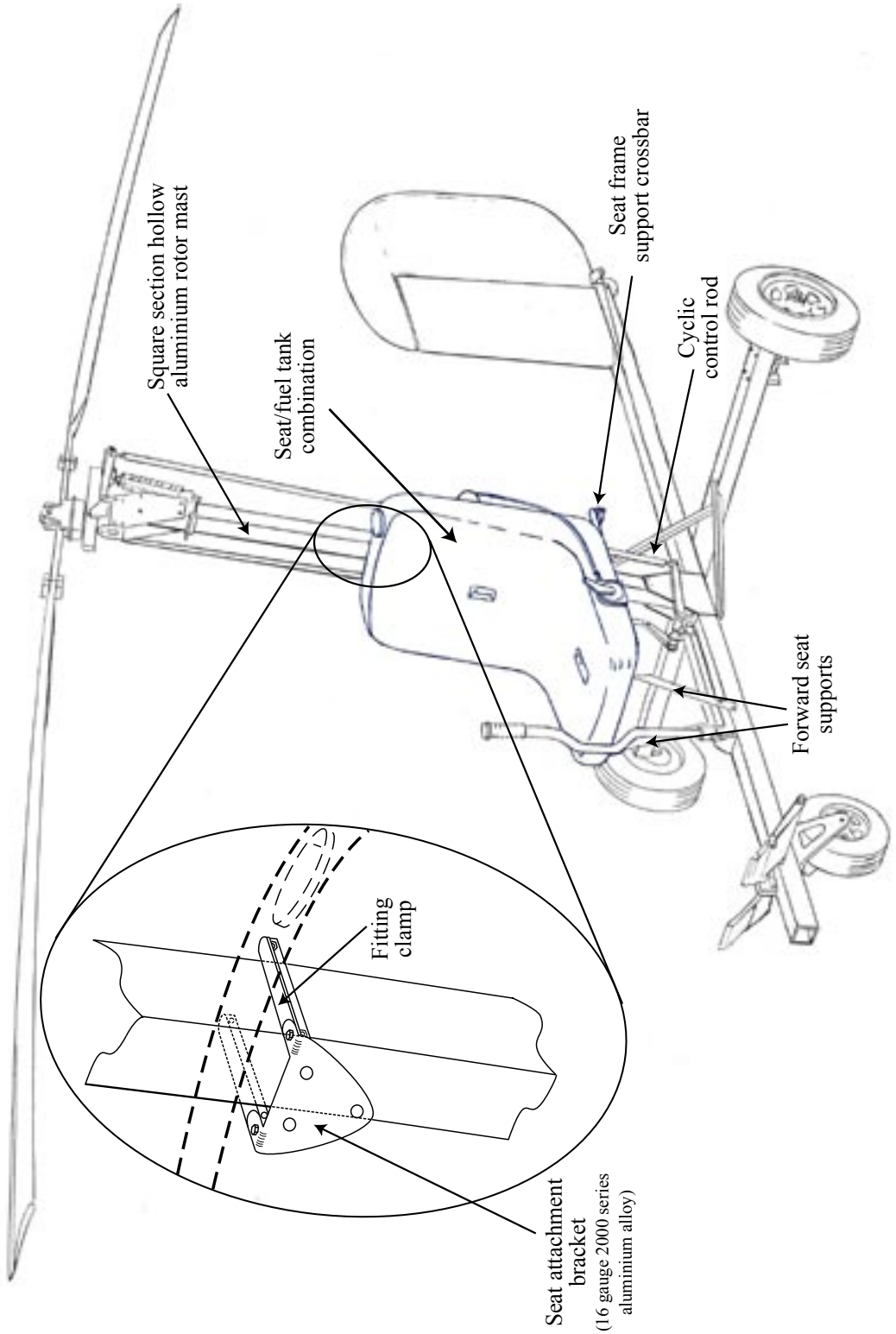

Diagram of the combined seat/fuel tank fixture

Adapted from a manufacturer's drawing

Figure 1

Pilot experience

The pilot was a very experienced glider and aero-tow pilot, but had little flight time on gyroplanes. He gained his Private Pilot's Licence (Gyroplanes) in October 2000 but had achieved only 33 hours on gyroplanes since then. Although his personal flying logbook was incomplete, analysis of the accident gyroplane's logbook shows that it is unlikely he had more than two hours flying gyroplanes within the last 12 months.

Other information

The weight, under 1g conditions, that the seat support structure was required to withstand with the accident pilot on board could potentially have been in the region of 128+ kg if the fuel tank were full (pilot 100+ kg, seat 4.4 kg and fuel 23 kg). If, on takeoff, the autogyro fuel tank contained only the reported 2.5 gallons, then this figure reduces to 113 kg, as a minimum. The empty weight of the autogyro is stated as 150 kg, the maximum take-off weight 272 kg, and so it appears that the gyroplane was, at most, only 10 kg below its maximum weight at takeoff. However, no maximum limit was quoted in any of the documentation for seat loading and, therefore, it is not known what effect upon the seat support structure a combined load of at least 113 kg would induce.

The investigation identified that a horizontal stabiliser had not been fitted to this gyroplane throughout the period of current ownership. In July 2004, the gyroplane community conducted tests in an attempt to determine the effectiveness of horizontal stabilisers on similar types of gyroplanes. They concluded that, at high speeds, there was a small improvement in pitch stability with the addition of a horizontal stabiliser but, at low speed, the effect was negligible. This accident occurred in a low speed flight regime.

Discussion

Although no fuel was discovered in the seat/fuel tank after the accident, it had been ruptured in the impact and this, together with the smell of fuel around the wreckage and evidence that the propeller was being driven, suggested that some fuel had been contained within the tank at the time of the accident. Therefore, fuel exhaustion was not considered a causal factor.

The only significant evidence found during the examination of damage that was inconsistent with having occurred during the accident, was the failure of the seat top attachment bracket. The left side lug of this bracket was found to have failed by fatigue cracking prior to the first impact with the trees. The right side had partially failed in fatigue. It was not possible to determine if the final overload failure of the right side occurred prior to, or as a consequence of, the impact. There was good evidence of long term fretting in a number of areas of the seat attachment points, looseness of the main load bearing rear crossbar for the seat, and vertical ovalisation of the crossbar attachment holes in the rotor mast.

Within the gyroplane's airframe, there is no provision for load/vibration damping to smooth the loads experienced by the airframe during taxiing, takeoff and landing, except for that provided by the pneumatic tyres. It is probable, because of the looseness of the seat frame support crossbar, that such loads induced damaging vertical and lateral cyclic loading in its attachment holes to the rotor mast which, over time, produced the ovalisation seen in these holes. As this ovalisation increased, an increasing vertical load would have been placed on the seat top attachment bracket, for which it was not designed, and this loading, combined with vibration and normal in-service loading, almost certainly initiated and propagated the fatigue cracking found in the bracket. At some point, possibly on the accident flight, the un-cracked portion of the right attachment lug could no longer support the vertical loads, and the bracket failed completely. It is possible that this failure then allowed the left-hand end of the crossbar to contact and restrict the movement of the left cyclic control rod which, together with the seat becoming insecure, could have led to the loss of control. Should the restriction have been present prior to the final

flight, then it remains to be explained why on the previous flight, and prior to takeoff on the accident flight, it was not noticed by either pilot. However, it is also possible that the right lug, which was only partially fractured by fatigue, finally failed during the impact sequence. In that case, no technical explanation for the loss of control was discovered during the investigation.

From an operational perspective, it is difficult to forecast the effect a loose, unstable seat would have on the handling characteristics of the gyroplane, aside from the fact that it would have been distracting. On encountering a control problem, it would appear that the pilot's first response was to throttle back to idle as a first attempt to resolve the situation. Lack of witness evidence prevents further analysis of the events in flight. However, the pilot's lack of recency on this gyroplane type may have hindered his ability to diagnose and respond to an emergency in a timely and correct manner.

Safety Recommendations

This gyroplane had been issued with a Permit to Fly, and was overseen by the Popular Flying Association. At the time of the accident there were four similar gyroplanes on the UK register, but none were reported to be in an airworthy condition. As it would appear that the failure of the seat top attachment resulted from a combination of looseness of the lower crossbar attachment bolts, in combination with in-service loading/vibration, concern is raised over the security of seat attachments on other gyroplanes of this, and similar, designs. The following safety recommendation is therefore made.

Safety Recommendation 2005-064

It is recommended that the Popular Flying Association (PFA) emphasise to all PFA Inspectors, and owners of Brock KB-2 and similar gyroplanes, the particular importance of checking the security of all seat attachments and fittings and, where looseness is found, that no cracking or deformation of the airframe or seat attachments is present.

Conclusions

No definitive cause of this accident was established as a result of the investigation. However, the possibility that the pilot lost control of the gyroplane, due to control difficulties precipitated by the seat attachment bracket failure occurring on the accident flight, could not be dismissed.