

Gyroglider Unregistered (not required)

AAIB Bulletin No: 1/98 Ref: EW/C97/5/5 Category: 2.3

Aircraft Type and Registration:	Gyroglider Unregistered (not required)
No & Type of Engines:	None
Year of Manufacture:	1995 approx
Date & Time (UTC):	17 May 1997 at 0930 hrs
Location:	Kemble Airfield
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - 1
Injuries:	Crew - Fatal - Passengers - Fatal
Nature of Damage:	Aircraft destroyed
Commander's Licence:	PPL(G)
Commander's Age:	60 years
Commander's Flying Experience:	Believed to be over 1,000 hours on gyrogliders
Information Source:	AAIB Field Investigation

Background

The gyroglider was acquired for a gyroplane club based at Kemble approximately two years before the accident. It was fundamentally a Bensen gyroplane without an engine. Two side-by-side seats were fitted with a central joystick type control and means of attaching a tow-rope to the front of the machine, which was equipped with a glider-type release. The machine had originally been purchased as a partly built Bensen gyroplane by one of the deceased pilots, an experienced gyroplane enthusiast and instructor who had adapted it into a gyroglider, having previously built a similar machine of his own.

The gyroglider was used extensively by the Kemble club for providing demonstration flights and for training prospective gyroplane pilots in the techniques of rotor management. The basic operating method was to tow the gyroglider along the runway behind a vehicle using a 100 foot long steel towrope. The gyroglider could be flown at a variety of speeds and heights but the general practice was to fly below 100 feet agl at a moderate tow speed. Although there was a facility to disconnect the rope from the gyroglider this was not normal practice. Usually, as the tow vehicle approached the end of the runway, the pilot landed the gyroglider before the car braked to a halt and set up either for

a repositioning ground tow or a flight in the opposite direction. The tow speed was usually pre-briefed by the pilot/instructor depending on the intended exercise, but it could be varied in flight in response to hand signals made by the pilot. For this reason, it was normal practice for a second person to sit in the tow vehicle facing rearwards to relay any hand signals from the pilot to the driver. Often a large number of flights along the runway would be completed in a single flying session. During the preceding two years, this gyroglider had reportedly suffered several accidents which had necessitated related repairs. No details of such repairs had been recorded.

Recent maintenance

Several weeks before the accident a visiting licensed gyroplane instructor and PFA authorised gyroplane inspector assisted club members to change the gyroglider's rotor. After inserting the teeter pivot bolt the inspector noticed that the rotor's teeter range was restricted because the hub bar was fouling (he thought) on the heads of four bolts which secured the rotor bearing housing. He declined to fly the gyroglider and it was not flown that day. Some time later, during another visit to the club, the same inspector noticed the gyroglider outside the hangar with the rotor head removed. He assumed that rectification was in progress but did not investigate further.

Following the comments made by the PFA inspector, on 2 March 1997 the gyroglider was inspected by a club member at the instigation of the club proprietor and in his presence. This club member was the most active 'instructor' pilot of the gyroglider and had acquired an estimated 50 hours of solo and instructional flying as pilot-in-charge. He had an engineering background and had been involved in maintaining the machine. He recollected that, when he made this inspection, the four bearing retaining bolts had been fitted with the nuts uppermost and that the threaded portion of the bolts protruded beyond the nuts.

Recent flights

On the evening of 24 April the club gyroglider 'instructor' flew the gyroglider for over two hours. The blades fitted at the time were constructed of aluminium and, since he himself had not carried out any maintenance work on the gyroglider, he assumed that the problem presented by the protruding bolt had been rectified by someone else. A week or two later the same member visited the club and observed another club member polishing the aluminium blades which at the time were not fitted to the gyroglider.

On the evening of 16 May (the day before the accident) there was an organised gathering of gyroplane and aircraft enthusiasts at the club. During the evening two gyrogliders were made available to give free demonstration flights to the visitors. One of the gyrogliders was this machine which belonged to the Kemble club; the other belonged to the pilot who had adapted the Kemble gyroglider and was of very similar construction. He and three friends had brought this second gyroglider from Cornwall to Kemble on a trailer attached to his car.

The pilot of the Kemble based gyroglider stated that he carried out a pre-flight inspection which included the control stick, control rods and teeter bolt but he may have overlooked the rotor head securing bolts. The passenger for this first flight confirmed that the pilot carried out a reasonably thorough pre-flight inspection. The gyroglider then flew satisfactorily throughout the evening and completed between 30 and 50 flights along the runway. At the end of flying, the gyroglider remained fully rigged and was returned to the club's gyroplane hangar. Some visitors stayed overnight in the club hangar, including the two men who were involved in the accident the next day.

History of the accident flight

On the day of the accident, the visiting gyroplane pilots from Cornwall initially went flying in the gyroglider which they had brought to Kemble. They attached an additional length of polypropylene rope between the towing car and the normal steel tow-rope with the effect of more than trebling its length. Three flights were then carried out along the runway in this gyroglider; during the second and third runs the pilot released the tow cable and executed a short period of free flight. The visitors then returned their gyroglider to the hangar area before seeking and receiving permission from the club proprietor to fly the Kemble based gyroglider. Before flying this gyroglider, its tow-rope release mechanism was secured with adhesive tape.

The pilot boarded the gyroglider with a fellow gyroplane pilot and they were towed onto the runway by a third colleague. On the runway, the tow driver saw the pilot (who had adapted the gyroglider) look over the gyroglider before commencing the first flying run, although he could not be specific about the depth of inspection made. The first flight was flown at an altitude of about 20 to 30 feet with gentle deliberate sideways movements; the tow car's speed was about 32 mph. On completion, the pilot instructed the tow driver to reverse direction and to tow back at the same speed. About halfway down the runway the pilot signalled for an increase in speed, which was provided and maintained for most of the remainder of the run. The ensemble then turned around for the third flight and during these manoeuvres the pilot commented to the tow car driver that he wanted to complete two more flights before exchanging places with him. The third tow was also at 32 mph and the gyroglider was flown at heights which were variously estimated to have been between 20 and 100 feet, again with gentle deliberate sideways movements. However, mid-way along the runway the tow driver suddenly noticed that the normally high drag on the car had ceased. On looking into his driving mirror, he saw that the gyroglider had crashed on the runway and he immediately took appropriate action to summon assistance.

An eye witness had seen the complete rotor separate from the fuselage and 'fly off'. The rotor landed on the grass beside the runway whilst tension in the polypropylene rope catapulted the fuselage downwards towards the tow car. The fuselage struck the runway whereupon the occupants were thrown out of the machine onto the tarmac. One person died at the scene; the other died during the ambulance journey to hospital. Post-mortem examination and toxicological tests indicated that there were no medical aspects pertinent to the accident.

Examination of the wreckage

Examination of the wreckage on the runway showed that the rotor had become detached due to the main rotor bearing pulling out of the bearing housing. The rotor bearing was still correctly attached, via the torque beam and gimbal, to the mast and the bearing lower cover plate was trapped between the bearing and the torque beam (Figure 1). The rotor was lying in the grass beside the runway, approximately level with the point of impact of the aircraft on the runway and 250 feet to the right.

Examination of the rotor head components showed that, although there was contact witness evidence which indicated that the bearing assembly bolts, with washers under both their heads and the nuts, had been installed at some time, there was no evidence of their having been installed at the time that the rotor detached, nor of their departing from the rotor in flight. Examination of the rotor, at the accident site, showed that it had not struck any part of the gyroglider before separation, nor was there any evidence of it having struck the ground with high rotational energy. A thorough search of the area failed to locate the four bearing housing bolts.

Examination of the remainder of the aircraft showed that the controls were still correctly connected and that all associated structural failures were consistent with the fuselage having struck the runway in a steeply nose-down attitude, whilst being reasonably level in roll.

Tests were conducted to establish the effects of fitting the bearing retaining bolts in various ways (see diagrams at Figure 2 and Figure 3). Correct length bolts were fitted in accordance with the design drawings held by the PFA; ie head uppermost, with no washer under the head. In this condition, when the rotor was made to teeter, the bolt heads did not interfere with the rotor assembly. However, because the main spindle bolt had been incorrectly fitted with a washer underneath its head, the spindle bolt head interfered with the underside of the rotor assembly and prevented it from reaching the teeter stops. When washers were fitted under the heads of the bearing retaining bolts, as the rotor teetered these bolt heads interfered with others projecting from the underside of the rotor assembly. The bearing retaining bolts were then fitted with their heads downwards and it was found that, if standard thickness stiff nuts without washers were installed on the nut threads, there was insufficient clearance for it to be possible to fit the rotor, even when no threads projected above the top of the nut.

Post-accident analysis

The AAIB obtained video and photographic images of the gyroglider before the accident. On the 13 August 1996 three of the four bearing retainer bolts were clearly visible on a video recording taken in the hangar (the fourth was probably present but obscured). The bolts could be seen to be fitted, with the retaining nuts downwards and with washers between the nuts and the bearing lower cover plate. However, as previously stated, on the 2 March 1997 the bolts were, according to a witness, noted to be incorrectly fitted with the nuts uppermost and associated rectification had been discussed. A photograph of the gyroglider in-flight taken on the evening before the accident revealed that all four bolts were missing at that time.

Testing at the AAIB indicated that after reassembling the rotor bearing into its housing, by heating the housing, a force of 870 pounds was required to extract it. The aircraft without the rotor components which had become detached weighed 120 pounds unoccupied. It was concluded that the interference fit alone had been sufficient to retain the rotor to the fuselage throughout the 30 to 50 flights undertaken during the previous evening, and possibly during flights preceding that event. It was also noted that the combined weight of the two deceased occupants was considerably greater than the combined weight of two persons of average size. The additional weight, combined with incremental loads caused by manoeuvring, was evidently sufficient to extract the bearing from the housing.

There were no records of maintenance, modification or flight time related to this machine. It was unregistered and did not require a log book, nor was there any requirement by the club, the British Rotorcraft Association or the Popular Flying Association to keep maintenance or flying records. A number of people had been involved in the upkeep of the machine, but there was no system or requirement for restricting its maintenance to authorised persons.

The deceased pilot, who had adapted the gyroglider, was very experienced and had been involved in the construction, maintenance and flying of gyroplanes and gyrogliders for over 30 years. He had also taught many gyro pilots to fly on his own gyroglider, which was built some 20 years previously and still operates with the St Merryn Club.

Regulations

No licence is required to fly a gyroglider; indeed, the pilot for most of the recent training flights and all of the demonstration flight did not possess a PPL(G). Whilst no adverse comment about his flying skill or experience is warranted, anyone could legally have flown the machine on the preceding evening when a significant number of passengers availed themselves of free demonstration flights.

More importantly, the maintenance of the gyroglider, being completely unregulated, had been conducted in a completely unstructured manner with no record of what work had been done on it or why, nor any record of who had worked on the machine. Furthermore, there was no requirement for work on any part of it to have been done using approved materials, nor for it to have been inspected by a competent person. As a result, the rotorhead was not assembled in accordance with the design drawings and the machine had not been inspected by a competent person after maintenance. In this regard, no legally enforceable rules or regulations had been broken because such aircraft are, by default, classified as kites or gliders (see Air Navigation Order, Schedule 1, Part A). Had it been powered by an engine rather than a towcar, the machine would have been classified as a gyroplane and its pilot would have required a PPL(G). Moreover, the machine would have been required to be registered and to have a Permit to Fly, with the attendant records and inspection procedures being monitored by the PFA.

The absence of an engine does not realistically convert a gyroplane into a 'kite' or a 'glider' in the accepted sense of the words. The gyroglider still has flying controls; it usually has two seats and it is subject to the same aerodynamic laws and rotor dynamics as the gyroplane. Being so similar to a gyroplane, it is a useful machine for the gyroplane fraternity because there are few two-seat gyroplanes with 'Permits to Fly' and pilots licensed to instruct upon them. Consequently, gyrogliders are extensively used for initial training and air experience flights. This usage is as close to Public Transport as any gyroplane is likely to come but without the safeguards applied to gyroplanes, or other comparable 'sporting' aircraft.

Safety Recommendations

As a result of the findings arising from this investigation, the following Safety Recommendations are made:-

Recommendation 97-26:

In conjunction with the Popular Flying Association (PFA), the British Rotorcraft Association should encourage owners and operators of gyrogliders to ensure that their machines are constructed, maintained and documented to the same standards as gyroplanes.

Recommendation 97-40:

The British Rotorcraft Association should encourage operators of gyrogliders to ensure that:

1. The pilot in command of a gyroglider in which another person is receiving instruction is the holder of a gyroglider instructor's rating issued by the British Rotorcraft Association.
2. The pilot in command of a gyroglider in which two or more persons are carried is the holder of a gyroglider pilot's rating issued by the British Rotorcraft Association.

3. The pilot in command of a gyroglider carrying one person is either the holder of a gyroglider pilot's rating issued by the British Rotorcraft Association or is under the supervision of a British Rotorcraft Association authorised gyroglider instructor.

Recommendation 97-41:

The British Rotorcraft Association should encourage all owners and operators of gyroplanes and/or gyrogliders to affiliate to the Association and abide by the Association's Policy and Rules.