Cricket MKIV Gyroplane, G-BXEM

AAIB Bulletin No: 5/2002	**Ref: EW/C2001/6/01**	**Category: 3**
Aircraft Type and Registration:	Cricket MKIV Gyroplane, G-BXEM	
No & Type of Engines:	1 Rotax 582 piston engine	
Year of Manufacture:	1996	
Date & Time (UTC):	1 June 2001 at 1700 hrs	
Location:	Henstridge Airfield, Somerset	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - Fatal	Passengers - N/A
Nature of Damage:	Gyroplane destroyed	
Commander's Licence:	Private pilots licence (Helicopters and gyroplanes)	
Commander's Age:	50	
Commander's Flying Experience:	78 hrs (of which .3 hrs on type)	
	Last 90 days 21 hrs	
	Last 28 days 18 hrs	
Information Source:	AAIB Field Investigation	

History of the flight

The pilot owned a Bensen B8 Gyroplane which he kept at a farm strip near his home. Aviation fuel was not available at the strip, and on the day of the accident the pilot drove from his home near Salisbury, Wilts to Henstridge, Somerset with the intention of collecting aviation fuel in cans and taking it back to the farm strip. The pilot left home between 0700 and 0800 hrs and arrived at Henstridge mid to late morning.

Henstridge is the home of a very active gyroplane community and the pilot spent much of the afternoon watching gyroplane flying, helping other enthusiasts prepare for flight and socialising. The pilot had obtained his PPL (Helicopters and Gyroplanes) in April 2001 having commenced his training about two years previously. In the two months since the issue of his licence, he had flown frequently in his own gyroplane and three other different gyroplane types.

In the late afternoon the pilot got into conversation with the owner of G-BXEM who agreed that he could take the Cricket Mk IV for a "short hop" followed by a circuit. A "short hop" is an exercise

used in gyroplane training and consists of a take-off and landing within the length of the runway. Normal training progression for beginners consists of extensive taxy training along the runway during which students master the technique of balancing the gyroplane on its mainwheels with the nosewheel off the ground, followed by "short hops" and finally circuit flying.

The weather was fine with scattered amounts of stratocumulus cloud and a surface wind of 300°/12 kts. The owner assisted the pilot to start the gyroplane and then watched as the aircraft taxied out to Runway 25 and carried out the planned "short hop". He and other witnesses watched the gyroplane gather speed on the take off roll, but noticed the pilot have difficulty in establishing the "wheel balanced" position. The nose was seen to rise then descend again with the nose-wheel hitting the ground hard before the craft eventually became airborne. It was then seen to fly along the runway at low altitude before landing and taxying back towards the Runway 25 threshold.

The pilot gave the owner a "thumbs up" as he passed him on the taxyway and continued to taxy to Runway 25. During the second take-off the pilot again had difficulty establishing a controlled "balanced" position; the nose was seen to rise violently and the stabiliser wheel at the rear of the airframe struck the ground. Thereafter the nose descended again and the nose-wheel was seen to strike the ground hard before the craft almost jumped airborne in a right-wheel-low attitude. Some eyewitnesses thought the craft was carrying out another "short hop", but as the craft approached the end of the runway, power was applied abruptly and the gyroplane carried out a steep left-banked turn to downwind.

As the gyroplane rolled out on the downwind leg it was seen to descend slightly and then establish level flight. Almost immediately the aircraft started an oscillation in pitch which continued the length of the downwind leg. One witness thought it was still pitching when it entered a steep turn to final. Some witnesses thought that the gyroplane's speed downwind was higher than normal, and others judged that the downwind leg had been angled towards the runway and that the final turn was therefore commenced from a position closer than normal to the runway centreline. An instructor who watched the gyroplane fly downwind was concerned to see the pitch oscillations, but as the aircraft began the final turn he considered that the pilot had recovered control and he therefore looked elsewhere. The bank was then seen by others to reduce slightly before being re-applied to the point where eyewitnesses estimate the rotor was at 90° to the ground. From this attitude the gyroplane was seen to fall sideways into the ground from an estimated height of around 100 feet with no change in bank angle. At no time during this sequence were witnesses aware of any apparent problem with the engine.

The aircraft hit the ground on its left side and came to rest a short distance away with the pilot trapped beneath the wreckage. Rescuers freed the pilot and attempted resuscitation but without success.

Aircraft Information

Gyroplane aerodynamics and handling

The fundamental difference between a helicopter and a gyroplane is that in powered flight the gyroplane flies with the rotor operating in autorotation. Forces generated by air flowing up through the blades provide not only the lift to keep the craft airborne but also the rotational force to keep the blades revolving. The power provided by the engine and propeller overcome the total drag of the machine and in level flight maintains the forward speed that ensures airflow through the rotors.

Gyroplane rotor blades are of generally light construction and are therefore quick to react to a change in applied force. Rotor speed tends to increase with increased disc loading and can decrease rapidly when disc loading is reduced. If the rotors are rapidly unloaded on some gyroplanes the machine can pitch forward abruptly, and if the direction of airflow through the blades is reversed rotor speed decreases sharply.

Turns are accomplished by tilting the rotor disc using the cyclic control. With the rotor disc tilted the horizontal component of the total reaction provides the centripetal force that causes the craft to turn. If the blades are unloaded and not producing lift, lateral control is not possible. As with a fixed wing aircraft power needs to be added to maintain speed especially when using steep angles of bank. Paragraph 3.7 (ii) of the Cricket Mk IV, Pilot's Handbook states:

> *Steep turns require rudder input and maximum power to maintain an angle of bank exceeding 45°. Above this angle, the aircraft will quickly lose airspeed and sink.*

Pilot Induced Oscillation (PIO)

A PIO is an inadvertent, sustained oscillation of an aircraft in either pitch or roll that may be caused by overcontrolling by the pilot or by the pilot input being out of phase with the restoring moments associated with the natural stability of the aircraft. A delay between control input and aircraft reaction may cause the pilot to apply more control input before the aircraft has reacted and the resultant overall response may be much greater than desired. If this sequence is allowed to develop, large oscillations may result to the point where catastrophic failure can occur. The PIO phenomena is well known in gyroplanes and is most likely to occur in gusty wind conditions or at high forward speeds where the control disc is at a low angle to the airflow and cyclic control is sensitive. Gyroplane pilots are therefore advised to avoid high speed flight in gusty conditions and to make only small control inputs. If a PIO is encountered the general advice is to reduce power and place the cyclic in the climb position. Experienced gyroplane pilots advise that a reduction in power will rapidly damp out a PIO. The accident pilot had previously been observed in a PIO whilst flying a friend's gyroplane. When questioned after landing it became clear that he had not been aware of the PIO.

Flight controls

The flight controls on the accident gyroplane differed from those on the pilot's Bensen B8. The Cricket Mk IV's cyclic is mounted on the airframe's keel beam forward of the seat, between the pilot's legs with the pivot point almost at floor level, and this arrangement is generally known as a base mounted cyclic. The movement of the cyclic is identical to a traditional floor mounted helicopter cyclic. The Bensen cyclic on the other hand is pivoted under and to the rear of the pilot's seat with the result that fore and aft movement of the cyclic also requires some vertical movement. With the cyclic fully aft the top of the cyclic is 74 cm above the airframe keel beam whilst with the cyclic fully forward the vertical displacement above the keel beam is 54 cm. The Bensen's cyclic arrangement is generally known as a "pump action stick".

The vast majority of the pilot's flying experience had been on gyroplanes with "pump action sticks". In the week prior to the accident he had twice attempted to fly gyroplanes with base mounted cyclics and on each occasion had been seen to have some difficulty with control of the craft on the ground. Experienced gyroplane instructors advise that it is not unusual for relatively inexperienced gyroplane pilots to have some difficulty with ground control when converting from one cyclic type to another.

Cricket Gyroplane Background

The Cricket Mk I was factory-produced and later home-built in the 1960s and 1970s. The Cricket Mks II and III were built by the designer for his own use. There is no record of a fatal accident to these types.

The Cricket Mk IV was built to meet engineering and test requirements set out in BCAR Section T. G-BXEM was the prototype Cricket MkIV; there is currently one other of the type on the UK register.

Weight and balance

The aircraft has a placarded minimum pilot weight of 75 kg. For pilots weighing less than 75 kg ballast may need to be provided. The accident pilot weighed 61 kg; ballast was not evident in the wreckage.

Meterological information

A Meteorological Office aftercast valid for 1800 hrs on 1 June shows a low pressure centred between Scotland and Norway and high pressure to the west of the British Isles. Numerous weak frontal systems were moving across the country from the north-west. At the time of the accident a weak warm front was over Wales and a weak occluded front over the English Channel with a light to moderate north-westerly flow. The weather at Henstridge was fine with good visibility under scattered clouds. The temperature was 18°C and the surface wind was 300°/13 kt increasing to 310°/18 kt at 500 feet with isolated light turbulence. Although the wind speed was well within the Pilots' Handbook Maximum Windspeed for Safe Operation, the instructor who had flown during the day considered the slightly gusting wind and associated turbulence made conditions unsuitable for student-pilot flying.

Medical and pathological information

A post-mortem examination found no evidence of any pre-existing disease which may have caused or contributed to the accident. The accident was judged to be non-survivable, and the pathologist considers death would have been instantaneous. Toxicological screening was negative except for a very low level of alcohol. It is possible that this was the vestige of lunch time ingestion but they may have been due to a post mortem artefact. The pathologist did not believe that the alcohol levels could have contributed to the accident.

Examination of the aircraft

Field Examination

The aircraft was lying close to the centre-line of Runway 25, within the airfield boundary, approximately 60 metres from the beginning of the paved surface. It had initially struck the ground approximately 6 metres to the south of its final resting-place. Examination of the aircraft and the ground markings confirmed that it had fallen on its left side with a high rate of descent and relatively low forward speed. The main rotor had been revolving at impact but it was not possible to assess the rotational speed. The three bladed propeller had suffered failure of two blades at their roots whilst the other blade was not damaged. The fuel tank had suffered impact damage which had resulted in the loss of any contents present.

Detailed Examination

The aircraft was examined and no evidence was found of pre-impact failure of the structure or flying controls. The engine was examined before being removed from the airframe. It was then transported to the premises of the UK agent for the unit where it was subjected to an extensive ground run under AAIB supervision. It was found to operate correctly and capable of giving sustained high power.

Analysis

No pre-impact defects were found during the examination of the wreckage that could have contributed to a loss of control. This analysis therefore concentrates on potential handling issues that may have caused or contributed to the accident.

The pilot had only recently qualified for the issue of his PPL(H/G) and in the weeks leading up to the accident was clearly enjoying the freedom that the PPL gives to fly various different gyroplane types. The main differences between his own gyroplane and the accident aircraft were the extra performance of the Cricket Mk IV and the different flying control system. From the evidence of experienced gyroplane instructors it appears that these differences may have contributed to the observed control problems during the two take-offs.

The PIO along the downwind leg is likely to have been the result of a combination of factors. The well known PIO causal factors of turbulence, relatively high speed and pilot inexperience were all present and it is likely that all three played a part in causing the PIO. In addition the pilot's relatively low weight and the lack of ballast may have rendered the Cricket more susceptible to PIO. The fact that no corrective action appears to have been taken by the pilot, and that he had previously been seen in a PIO without being aware of the situation tends to indicate that he was also unaware of the problem on the accident flight.

Evidence from several eyewitnesses indicates that the gyroplane was at or above the normal speed of about 60 kts at the end of the downwind leg; however, the impact appears to have occurred at very low forward speed. Even taking into account that some of this apparent loss of energy can be accounted for by the into-wind turn at the end of the downwind leg, the majority of the energy loss is likely to have occurred during the manoeuvring between the downind leg and the final impact point.

One eyewitness considered that the PIO seen on the downwind leg continued into the final turn, and it is therefore possible that the loss of energy was caused by unloading of the rotor disc. However, given that the flying instructor on the ground thought that the PIO problems had been solved when he saw the gyroplane enter the final turn, it seems more likely that at least part of the energy loss was due to the drag generated in the very steeply banked final turn.

The cause of the eventual loss of control cannot be determined. One or two eyewitnesses thought rotor speed had reduced prior to impact, but most witnesses described seeing a disc rather than individual blades which indicates that rotor rpm had not decayed completely. However, even a 20% reduction of rotor rpm can lead to control problems that may not be recoverable. On the other hand, it could also be the case that a combination of high angle of bank and low forward speed caused a high rate of descent to develop from which the pilot was unable to recover in the height available.

Although it has not been possible to determine the cause of this accident with any certainty, much of the evidence points towards the pilot experiencing handling difficulties in a gyroplane with considerably more performance and a different flying control system relative to the gyroplane with which he was familiar. If the pilot had been under the supervision of a qualified flying instructor for his first flights in the unfamiliar type, it is entirely possible that these handling difficulties could have been identified and remedied. The CAA has addressed this issue in its recently revised General Information Document No 5 Version 3, Requirements for the Grant of a UK Private Pilot's Licence (Gyroplanes). Part 9 of this document, entitled Additional Manufacture Types, states:

> *For the time being gyroplane PPL's are issued with the privilege to fly one type of gyroplane, i.e. single engine gyroplane.*
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> *Pilots wishing to fly gyroplanes different from the specific manufactured type that they received flight training on, shall receive appropriate differences training from a gyroplane assistant flight instructor or flight instructor and have their log book endorsed by the instructor. In the case of single seat gyroplanes arrangements shall be made with an instructor for the differences to be covered and where necessary a flight demonstration by the pilot to confirm his/her competency; a log book endorsement shall also be made.*
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> *There may be occasions when a rare single seat type of gyroplane is transferred ownership or another pilot wishes to fly someone else's machine, and there is no instructor with the appropriate experience on the machine. If this is the case the qualified pilot on the specific type should arrange with an instructor for the supervision of such difference training and the log book endorsement to be made by the instructor.*
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> *In the interest of flight safety, it is imperative that the above differences training is carried out.*