Montgomerie-Bensen B8MR, G-BXDC

AAIB Bulletin No: 1/2001

Ref: EW/C2000/04/03 - Category: 2.3

Aircraft Type and Registration:	Montgomerie-Bensen B8MR, G-BXDC
No & Type of Engines:	1 Rotax 582 piston engine
Year of Manufacture:	1999
Date & Time (UTC):	16 April 2000 at 1411 hrs
Location:	Carlisle Airport, Cumbria
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - 1 - Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence (gyroplanes)
Commander's Age:	51 years
Commander's Flying Experience:	67 hours (of which 30 were on type)
	Last 90 days - 44 hours
	Last 28 days - 43 hours
Information Source:	AAIB Field Investigation

Background information

The pilot first showed an active interest in autogyros when in March 1999 he visited Carlisle Airport for a trial lesson. He had not flown before and enjoyed the experience so much that he flew again the same day and agreed to embark on a formal training programme with an instructor who was authorised by the CAA to conduct dual and single seat autogyro training as well as flight examinations. The instructor reported that his student approached all matters to do with his flying 'with a great deal of enthusiasm and a fair degree of ability'.

From the start of his course until January 2000 the pilot undertook dual instruction, mainly at weekends, on a two seater VPM M16 autogyro. By March 2000 he was sufficiently experienced to transfer to the 'open frame' single-seat Benson autogyro. He flew this for approximately 20 hours, carrying out mainly short 'hops' along the length of the runway and practising balancing on the main wheels before progressing to flying the aircraft in the visual circuit and carrying out general handling exercises. During the single-seat flights the instructor stood close by the runway and communicated with his student via a radio link to headphones installed in the student's helmet. By mid April 2000 the pilot had reached a satisfactory standard and passed a General Flight Test (GFT) examination in the two-seater VPM autogyro for a Private Pilot's Licence (gyroplanes).

At some time during his training the pilot had bought a half share in a Benson Merlin autogyro. This variant differed from the 'open frame' version by the addition of a fibreglass nose fairing streamlining the nose of the aircraft and partially enclosing the pilot's seating position.

History of the flight

On the day of the accident the pilot arrived at the airfield at approximately 1100 hrs where he met the instructor and said he wanted to carry out some practice 'wheel balancing' and 'runway hops' in his own machine. Although he was familiar with the exercises to be carried out he still discussed the procedures and was briefed by the instructor. Later the instructor saw the pilot taxiing his autogyro along the runway. He continued to watch several of the runs down the runway most of which were carried out on or just above the surface. One run however consisted of a low flight at approximately 30 feet above the middle section of the runway. The instructor was satisfied with the pilot's progress and described every run as appearing normal and flown in accordance with the briefing. The instructor however did not see the final flight.

A college student, visiting the control tower, saw the pilot carrying out his exercises. For at least an hour he saw the autogyro carry out short hops along the runway, rising each time to approximately 10 feet above the surface. Each run ended well before the end of Runway 07, whereupon the aircraft would backtrack the runway before repeating its run.

A farmer driving around the northern perimeter of the airfield noticed the aircraft in flight at a height of approximately 30 to 40 feet halfway along the runway. He lost sight of it briefly before it reappeared at the same height now three quarters of the way along the runway length. The aircraft was then seen to enter a shallow descent to a height of 15 feet at a speed estimated to be consistent with circuit speed and not that for landing. By this time it was approaching the airfield boundary hedge. The autogyro then climbed to 30 feet, the nose dropped suddenly and it entered a steep decent at an angle of approximately 45°. The final sighting was of a rotor blade vertically in the air as the autogyro disappeared behind the hedges.

Another pilot, positioned on the airfield outside the local flight centre, saw and heard the later stages of the accident flight. He reported that, with the autogyro three quarters of the way along the runway at a height of 15 to 20 feet above the surface, the engine was throttled back and a shallow descent initiated. It then sounded as if the throttle was increased to full power as the autogyro climbed to 30 to 40 feet before pitching sharply downwards and descending at an angle of 45° whilst rolling to the left.

Those that saw the accident proceeded immediately to the scene to find that the pilot had received fatal injuries. Post mortem examination revealed no evidence of any pre-existing disease which may have caused or contributed to the cause of the accident.

At the time of the accident the weather was noted by the 'air/ground' radio operator in the control tower. He recorded a surface wind of 130°/10 kt with visibility greater that 10 km. The temperature was 10°C with scattered cloud at 3,500 feet and a QNH of 996 mb.

Aircraft description

The Montgomerie-Bensen B8MR is a single-seat gyroplane powered by a Rotax 582 cc two-stroke twin piston engine with a speed reduction gearbox. It drives a three-bladed fixed pitch pusher propeller, of plastic composite construction. The propeller is 60 inches in diameter and rotates clockwise, viewed from the rear, at a maximum speed of around 2,560 RPM.

The aircraft primary structure consists of a keel beam with a rotor mast attached. A cockpit fibreglass fairing incorporating the pilot's seat and fuel tanks is fitted forward of the rotor mast and the engine is mounted behind the mast. An empennage, consisting of a vertical fin and rudder and a fixed horizontal tailplane, is attached at the rear of the keel. The aircraft has a tricycle landing gear, with the nose wheel attached at the forward end of the keel and main gear wheels carried on a crossbeam fixed to the keel.

Lift is provided by a two-bladed aluminium rotor which is driven in flight by autorotative forces generated by the airflow passing over the blades; it can be pre-spun before take off by a flexible shaft powered from the engine. The rotor is 22 foot in diameter and rotates anti-clockwise, viewed from above. Rotor speed in cruising flight is around 300 to 350 RPM.

Flight control is by means of a control stick connected by a rod and bellcrank system to mechanisms mounted at the top of the rotor mast that alter the pitch and/or roll angle of the rotor axis, and by pedals operating the rudder. A hand-throttle lever mounted on the left side of the cockpit fairing controls engine power.

Aircraft records

Records indicated that G-BXDC (Serial No PFA 9/01-1219) and its engine (Serial No 4105531) had been constructed in 1997. After a satisfactory flight test on 23 December 1999 the CAA and the Popular Flying Association (PFA) issued following documents:

> CAA Permit to Fly: 7 January 2000
>
> PFA Certificate of Validity - Permit to Fly (valid for 1 year): 7 January 2000
>
> CAA Certificate of Registration: 14 January 2000
>
> CAA Certificate of Registration: 28 January 2000

The PFA Operating Limitations document stated that:

> Manoeuvres involving a deliberate reduction in normal 'g' shall be avoided.
>
> Maximum Total Weight Authorised: 280 kg (617 lb).
>
> Maximum Indicated Airspeed: 80 kt [92 mph].

The records indicated that at the time of the accident the aircraft and engine had operated for approximately 22 hours in 26 flights. The propeller had been replaced on 3 March 2000. No evidence was found to suggest that the aircraft or engine had suffered significant failure or malfunction prior to the accident flight.

Accident site

G-BDXC had crashed in a pasture field just outside the eastern boundary of Carlisle Airport (Figure 1). A narrow road with a six foot high hedge on either verge ran between the field and the airport boundary. The western portion of the field, adjacent to the road, sloped gently down to the south, but a steep downward slope to the east started approximately 150 metres from the road. In the area of the crash site the ground was of medium density soil with a covering of short grass.

The initial ground impact mark was located 17 metres into the field from the hedge bordering its western edge. This point was approximately 150 metres beyond the end of Runway 07 (066° magnetic) and 38 metres left of the extended runway centreline. Initial ground contact had been made by the nose landing gear and the forward parts of the keel and the cockpit fairing. Further relatively deep ground marks, including substantial propeller and rotor blade chops, extended over a distance of 5 metres along the impact direction.

The main wreckage was found 18 metres from the initial ground impact point. The wreckage trail terminated with the nose landing gear and the front parts of the keel and cockpit fairing, 22.5 metres from the initial ground impact point. Numerous small wreckage items were found over an area extending approximately 14 metres from the initial ground impact point and laterally 10 metres left and 8 metres right of the trail centreline, consisting largely of cockpit instruments and fragments of propeller blade and cockpit fairing.

There was no evidence of the aircraft having made contact with either of the hedges bordering the road. However, two portions of propeller blade tip were found isolated from the main wreckage area, one on the road and the other at the eastern edge of the field. These had detached approximately 30 metres and 20 metres respectively prior to the aircraft's initial ground impact.

The aircraft had struck the ground on a track of 039°M and with a flight path descent angle of 30° to the horizontal while banked 25° left and pitched approximately 20° nose down. The forward speed was estimated to have been in the order of 30 to 50 kt (35 to 58 mph). Both the rotor and the propeller had been rotating at relatively high speed at the time of ground impact.

Wreckage examination

The aircraft's standard of construction was generally good with the exception of the attachment of the throttle lever to the rotary shaft of the throttle cable quadrant box. The lever was retained on the shaft by a nut and keyed to the shaft by a pin passing through the lever and the shaft. The pin, consisting of a portion of a 0.125 inch diameter twist drill, was found to have no positive axial restraint. However, the pin was found in place and the evidence indicated that the nut had maintained the lever tight on the shaft and that this feature had not been relevant to the accident.

Markings and localised damage to one rotor blade, with portions of propeller blade embedded in the damaged area, showed that the underside of the rotor blade had been struck by at least two propeller blades, from trailing edge to leading edge. Comparison with a similar gyroplane showed that with the static rotor pitched nose-up onto its back stop the blades have approximately 4.5 inches vertical separation from the propeller disc. Airframe and rotor flexibility could reduce this separation in the event of a rapid nose-down pitch of the aircraft relative to the rotor disc (Note: 'rotor disc' is the term for the plane described by the tips of the rotating rotor blades). The position of the propeller blade strikes found on the rotor blade suggested that some distortion, causing the top of the mast to bend rearwards, had been present at the time that the collisions occurred. Rotational directions are such that both rotor and propeller blades travel from left to right at the point of intersection of the propeller and rotor discs. At this point the propeller tip speed would be appreciably higher than the local rotor blade speed over the normal operating range of propeller and rotor.

Examination of the wreckage showed that the aircraft had been complete at ground impact, with the exception of parts of the propeller blade tips. It had suffered substantial damage, all of which appeared consistent with the combined effects of propeller/rotor blade collision and ground impact and no signs were found to indicate failure or anomaly prior to the propeller/rotor collision. The possibility of a flight control system jam could not be totally dismissed in the circumstances, although no signs were found to suggest that this may have occurred. No evidence was found to indicate pre-impact disconnection of flight control systems. Fuel tank contents had leaked from system ruptures but vegetation discoloration showed that appreciable quantities of fuel had been present at the time of impact

'Power pushover'

In many autogyros, as in the Benson Merlin, the line of engine thrust is higher than the centre of gravity and the centre of fuselage drag. This does not cause any problems so long as the machine is 'hanging' from the rotor blades in a positive 'g' situation. The thrust produced by the rotor blades overpowers the tendency of the engine thrust to push the autogyro nose down. If however the rotor thrust is reduced or eliminated, the resulting couple formed by engine thrust and drag destabilises the machine, pitching it nose down. The resulting manoeuvre is called a 'power pushover'. A number of situations have been identified as having a high risk of a power pushover occurring. Of these the following may have relevance to this accident:

- Pilot induced oscillations (PIO), can occur when control movement is out of phase with the aircraft's natural movement. Large pitch oscillations can cause the rotor disc to tilt forward, suddenly reducing the load on the blades. In this condition engine thrust can pitch the gyro nose down.

- The pilot can 'unload' the rotor by flying a sharp 'pitchover' manoeuvre, pushing the nose down while high power is applied.

With training and experience the pilot can avoid occurrences of a 'power pushover' by reducing engine power in the event of a PIO developing, reducing speed, or changing power settings before changing pitch.

Conclusion

The pilot involved in this accident was relatively inexperienced. He had planned to carry out a series of runs down the runway, balancing on the main wheels, followed by shorts 'hops' to a height of several feet above the surface. For the most part each run, consisting of several hops, had been terminated well before the end of the runway. It is possible that, towards the end of the final run, the pilot was concerned to land back on the limited amount of runway remaining. When he realised that this was impossible he applied power, climbed to 30 to 40 feet and decided to land in the field beyond the runway. This necessitated a fairly abrupt pushover to lose height. Such a manoeuvre would have unloaded the rotor and, with engine thrust applied, could have induced an incipient power pushover. With the rotor RPM dropping below the normal operating range, as a result of the pushover, a loss of control would have resulted.