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Collision with terrain

Proserpine/Whitsunday Coast Airport, Qld

2 April 2009

Abstract

On 2 April 2009, a flight instructor and student pilot in a Robinson Helicopter Company R22, registered VH-YDA, were conducting normal circuit and autorotation training at Proserpine/Whitsunday Coast Airport, Qld. At 1400 Eastern Standard Time, the helicopter collided with terrain on the grass at the side of the departure end of runway 11. The helicopter was seriously damaged and the instructor was seriously injured.

After the accident, neither pilot could recall any of the flight sequence immediately before the impact. There were no witnesses to the accident and no relevant recorded data. An examination of the helicopter wreckage indicated that there were no pre-impact defects. Due to a lack of information, the investigation was unable to determine why the helicopter collided with terrain.

The investigation found that the use of safety helmets would reduce the risk of pilot injury during door(s)-off operations.

The investigation also found that the helicopter was about 11 kg overweight on takeoff for the flight.

FACTUAL INFORMATION

History of the flight

On 2 April 2009, at about 1236 Eastern Standard Time¹, a flight instructor and student pilot in a Robinson Helicopter Company R22 Beta, registered VH-YDA, departed from Whitsunday Aerodrome, near Airlie Beach, Qld, for Proserpine/Whitsunday Coast Airport on a dual training flight. The student flew the helicopter to Proserpine to conduct normal circuits and autorotations².

The pilots recalled that the weather was clear and the wind was light and variable for the circuits to runway 11 at Proserpine. After two normal circuits, the student conducted a further two or three circuits that included simulated engine failures and autorotations. The student reported that the autorotations were initiated at 1,000 feet above ground level (AGL) on short final approach and were terminated over the grass adjacent to the first half of runway 11 (Figure 1). The instructor recalled that the student's flying was good, except for an early flare on the first autorotation.

- 1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time, as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.
- 2 A descent with power off. In autorotation, the helicopter's rotor system continues to rotate at about cruise RPM as a result of the air flowing upwards through the main rotor system.

Figure 1: Proserpine/Whitsunday Coast Airport

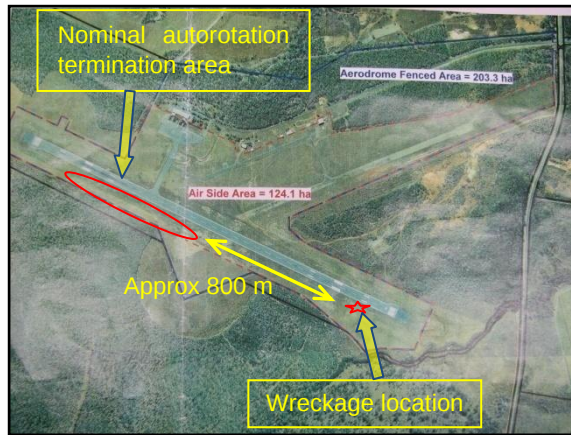


Image courtesy of Proserpine/Whitsunday Coast Airport

At about 1400, the helicopter collided with terrain on the grass alongside the departure end of runway 11. The helicopter was seriously damaged and the instructor was seriously injured. Both pilots were unable to recall any details of the flight immediately before the impact.

Pilot information

The instructor held a Commercial Pilot (Helicopter) Licence that was issued on 20 February 2006. He also held a Grade 1 Helicopter Instructor Rating that was issued on 22 January 2009. He was endorsed to fly the Hughes 269, Robinson R22, Robinson R44, and Bell 206 III helicopter types. He held a Class 1 Medical Certificate that was due to expire on 24 September 2009.

The instructor's flying experience included:

- 1,504 total flight hours
- 622 instruction flight hours
- 496 R22 flight hours

The instructor's most recent check flight was a flight test for upgrade to Grade 1 Instructor Rating on 22 January 2009. That test was conducted by an Approved Testing Officer (ATO) in an R44 helicopter. The ATO advised that a number of autorotations were competently performed by the instructor, but that he could not recall if an engine failure after takeoff was demonstrated.

The instructor had joined the company 2 years before the accident, initially on a part-time basis. From December 2007 he had been employed full-time.

The instructor reported that he was well rested and in good health on the day of the accident.

The student pilot held a Student Pilot License that was issued on 22 September 2008. He was in the early stages of training for a Commercial Pilot (Helicopter) License and was close to undertaking his first solo flight. He had a total of 17 flight hours. The student pilot held a Class 1 Medical Certificate that was due to expire on 5 August 2009.

The student reported that he was fit and well on the day of the accident.

Helicopter information

The helicopter, serial number 4346, was manufactured in the US in 2008. The total aircraft time in service was 169.4 hours.

The helicopter had a valid Certificate of Airworthiness, and a maintenance release that was valid until 29 January 2010. There were no overdue maintenance requirements for the helicopter. The most recent maintenance was a routine Airworthiness Directive inspection on 10 March 2009, and a 50-hourly engine inspection on 4 March 2009. The carburettor was removed due to throttle shaft binding and repaired on 6 November 2008 at an engine overhaul facility.

The operator's flight record sheet indicated that there was 114 L of fuel on board at start-up. The instructor recalled departing for the flight with about 100 L of fuel. Based on there having been 100 L of fuel on board at departure, and the operator's planning fuel consumption rate of 36 L per hour, the fuel quantity at the time of the accident should have been about 50 L.

About 40 L of fuel was drained from the helicopter wreckage on the accident site and an additional 13 L was drained during the subsequent wreckage examination.

The initial take-off weight of the helicopter was calculated to have been 11 kg over its gross weight limit of 622 kg. On that basis, the helicopter was about 25 kg below the gross weight limit at the time of the accident.

Meteorological information

Bureau of Meteorology observations at Proserpine/Whitsunday Coast Airport at 1400 on 2 April 2009 indicated that the temperature was

33° C with a dew point of 15° C. The wind was from 290° T at 4 kts. The QNH³ was 1010 hPa.

A carburettor ice probability chart showed that carburettor ice in the observed weather conditions was very unlikely.

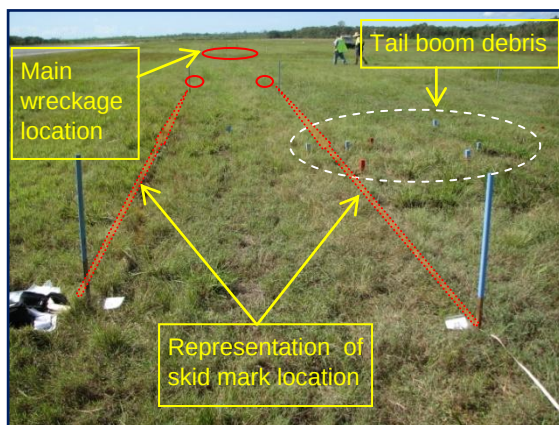
Accident site information

The Australian Transport Safety Bureau (ATSB) conducted an on-site investigation after the helicopter wreckage was removed.

The accident site was located adjacent to the departure end of runway 11, 16 m from the southern side of the runway. The accident site was between 800 and 1,600 m from the area reportedly used for power recovery termination after the autorotations (Figure 1).

Parallel skid marks about 10 m long and running parallel to runway 11 were found on the ground at the accident site. The debris from the tail boom section of the helicopter was located about 5 m from the start of the skid marks (Figure 2).

Figure 2: Ground marks at the accident site



About 2 m beyond the end of the skid marks, were two holes 1.98 m apart, consistent with the width of the helicopter's skid landing gear. About 62 m further on, there were impact marks and debris where the helicopter came to rest (Figure 3).

Figure 3: Helicopter wreckage on site



Photo courtesy of the aircraft operator

Wreckage examination

Both main rotor blades were still attached to the main rotor mast, with no evidence of delamination or coning. The main rotor blades were subject to impact damage. One blade was twisted and exhibited bending at the midspan. The other blade exhibited evidence of paint transfer near the blade tip that was consistent with it impacting the tail boom.

The horizontal stabilizer was separated from the boom. The tail rotor driveshaft was fractured and displayed torsional damage that was consistent with a main rotor blade impacting the tail boom while rotating. The tail rotor blades showed evidence of impact damage. One blade was fractured and the other was bent to the right.

Drive train continuity was confirmed with no pre-impact defect found. Both engine-to-main-rotor-drive vee-belts were tensioned and one belt was partially displaced on the upper sheave. The displaced belt had a helical mark consistent with engine rotation at impact. The sprag clutch⁴ operated normally.

No evidence was found during engine examination of anything to prevent the engine from operating normally. A post-accident engine run was not performed. The fuel system was tested and fuel was able to flow from the tanks to the carburettor. The carburettor was examined with no pre-impact

3 Altimeter subscale barometric pressure setting to provide altimeter indication of an aircraft's altitude relative to mean sea level.

4 A sprag is a one-way freewheel clutch. In the event of an engine failure, the sprag clutch allows the main rotor to continue rotating faster than the engine to allow for autorotation.

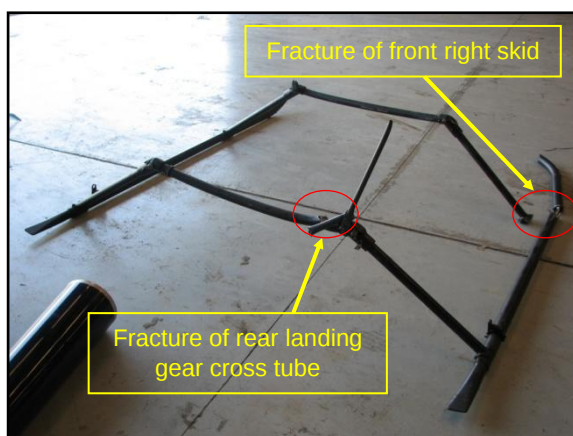
defect found. The continuity of the engine control system was checked as serviceable. The direct-drive squirrel-cage engine fan had scoring damage consistent with engine operation at the time of impact.

A flight control continuity check did not show any pre-impact defect. The tail rotor pedals were found in the full right-pedal-forward position, which was consistent with the position of the tail rotor control rod when the main rotor blade severed the tail boom. A right-pedal-forward position can be expected in response to low main rotor drive torque, such as when in autorotation.

The helicopter warning lights and warning horn system were found to be serviceable. The governor control switch was found selected to the ON position.

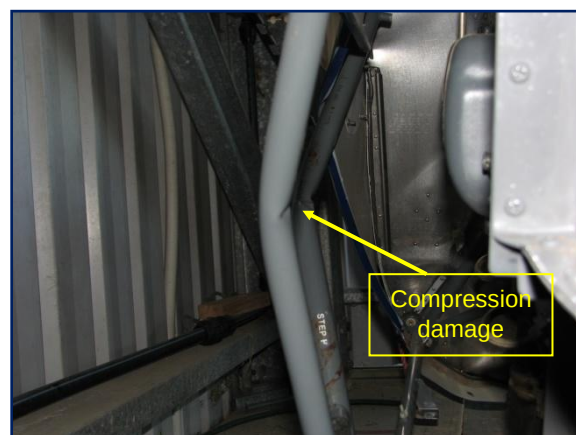
The landing gear skids displayed vertical impact loads and some torsion damage (Figure 4).

Figure 4: Skid landing gear assembly



The tubular steel engine frame above the left rear skid attachment had compression damage as a result of high landing energy. The tubular steel frame above the right rear skid attachment had fractured and displayed compression and twisting damage (Figure 5).

Figure 5: Compression damage to the left engine frame



During the examination, no evidence of tailskid damage was found. There was also no evidence that the main rotor blade had entered the cabin.

Survival aspects

The R22 Pilot Operating Handbook (POH) stated that door-off operation was approved with either one or both doors removed. The helicopter was found with the left cabin door removed. The instructor was seated in the left seat.

The instructor received a full-thickness laceration of the rear section of the scalp, with exposure of the skull. This wound required about 60 stitches. The shape and extent of the injury was consistent with the instructor being struck by a rotating main rotor blade during the accident sequence. That was supported by the instructor's headset cable being found wound around the main rotor mast and hub (Figure 6).

Figure 6: Instructor's headset cable and main rotor mast



Image courtesy of helicopter operator

The student pilot had minor injuries from a seat belt attachment.

The standard seat belt installation in the R22 included a combined seat belt and inertia-reel shoulder strap (Figure 7). The helicopter manufacturer confirmed that only the 3-point harness was available on the R22 as the airframe structure did not allow for a 4-point harness.⁵

No damage or defects were found on the seatbelts worn by the instructor and student.

Figure 7: Combined seat belt and inertia-reel shoulder strap.



There was no regulatory requirement for safety helmets to be worn during helicopter flying training and the operator had no specific requirement in this regard. Neither pilot was wearing a safety helmet on the day of the accident.

Simulation of engine failure training

The R22 POH advised that power failure may be caused by either an engine or drive system failure, and will usually be indicated by the low RPM horn. There was a precaution to avoid applying aft cyclic during touchdown or during ground sliding to prevent a possible blade strike to the tail boom.

The POH procedure for recovery from power failure between 8 and 500 ft AGL was to lower the collective immediately to maintain rotor RPM, and adjust the collective to maintain the RPM in the green arc, or to apply full down collective if light helicopter weight prevents attaining above 97% RPM.⁶ The POH stated that pilot's should maintain airspeed until approaching the ground, and that then a cyclic flare should be commenced to reduce the helicopter's rate of descent and forward speed. At about 8 ft AGL, the pilot should apply forward cyclic to level the helicopter and, just before touchdown, the collective should be raised to cushion the landing. Touchdown is with the skids level and the nose straight.

The operator had no documented procedures on how to conduct engine failure after take-off

⁵ The airframe structure for the manufacturer's R44 helicopter does allow for a 4-point harness.

⁶ Amongst other variables, RPM in autorotation is affected by the weight of a helicopter. In general, the greater a helicopter's weight, the higher the RPM in autorotation.

training. The chief pilot reported that, during advanced training after solo, low-level engine failures were taught starting from entry points of 300 ft, 200 ft and 100 ft AGL, with a minimum speed of 60 kts. There was no regulatory requirement for that training prior to solo. The chief pilot reported that the instructor was not authorised to conduct simulated low-level engine failures after takeoff prior to solo.

The instructor reported that he would demonstrate emergencies, such as engine failure after takeoff, before a student went solo because students needed a reasonable understanding of what to do if those emergencies occurred. The instructor initially reported that he might have conducted an engine failure after takeoff demonstration at some time during the accident flight, because the student was doing well. However, the instructor later considered it unlikely, as the focus of the training that day was on autorotations.

The instructor advised that, once a student was entering autorotations competently, he would conduct autorotations from 500 ft AGL after takeoff, so that the student could practice the flare and termination without having to conduct a full circuit.

An experienced Grade 1 instructor advised that 1,300 to 1,600 m was probably a sufficient total horizontal distance in which to conduct a simulated engine failure after takeoff; including from the takeoff to the autorotative landing straight ahead.

ANALYSIS

Introduction

The investigation considered the operational factors with the potential to have contributed to the development of the accident and occupant survivability. The following analysis examines those factors.

Collision with terrain

The compression damage to the helicopter structure indicated a high rate of descent, and the distance between the two sets of ground marks indicated significant forward speed at the time of impact.

The investigation considered a number of potential factors that could have affected the helicopter's rate of descent and forward speed at that time. The most likely factors were a real engine failure, a simulated engine power loss, or a drive train failure.

No evidence of pre-impact defects was found during the engine and drive train examinations. The scoring damage to the direct-drive squirrel-cage engine fan was consistent with engine operation at the time of impact. Therefore, the investigation considered the simulation of an engine power loss was the most likely factor.

The pilots recalled conducting simulated engine power loss training (autorotations) from 1,000 ft above ground level (AGL), but they could not recall if the accident occurred during such a sequence. An autorotation from 1,000 ft AGL was considered an unlikely precursor to the accident, because the accident site was at least 800 m from the area reportedly used for autorotation terminations, and the student had successfully completed two or three autorotations from 1,000 ft and 'reached' that area.

The instructor indicated that, depending on a student's progress, and in the interests of maximising training, he would conduct autorotations from 500 ft AGL after takeoff. There were some indications that the pilots were in the process of conducting an autorotation from 500 ft AGL, or from a simulated engine failure after takeoff, when the helicopter impacted the ground. The location of the accident site – up to 1,600 m from the area that was reportedly used for autorotation terminations – might have allowed sufficient distance for the helicopter to take off and climb to a suitable height for a further simulated engine failure within the length of the runway.

Although the chief pilot advised that engine failure after take-off training was only conducted after a student went solo, the instructor reported that he would demonstrate an engine failure after takeoff before a student went solo. In this case, the instructor considered the student was not yet ready for an engine failure after take-off demonstration, which makes it more likely that, before the accident, they were conducting an expeditious simulated engine failure from 500 ft AGL.

In the absence of a pre-impact rotor drive defect, the indication of low drive torque from the right-pedal-forward position of the tail rotor pedals was consistent with low engine power at ground impact. In the case of engine power loss below 500 ft, there can be less time and performance to recover from an autorotation than from 1,000 ft AGL. The handling pilot is busy, and may not restore engine power in time to avoid a collision with terrain. In this case, an added difficulty was the 4 kt downwind recorded at the airport.

Although there were some indicators that the pilots were in the process of conducting a simulated engine failure at or below 500 ft AGL before the collision with terrain, there was insufficient evidence to conclusively establish the reason for the accident.

Survival aspects

In this occurrence, the helicopter's left door was removed, as permitted by the R22 Pilot's Operating Handbook (POH), and the instructor, who was seated by the open doorway, sustained the more serious injury of the two pilots. Given the instructor was probably struck by a main rotor blade, and that the blades did not enter the cabin, the instructor was probably partially outside the cabin at some time during the accident sequence. If the left door had been installed, the instructor might have been confined to within the cabin during the accident and avoided a serious injury.

The non-availability of a 4-point harness for the R22 means that R22 pilots are afforded less upper body restraint compared with the belt/inertia reel pilot restraints that are fitted. If door(s)-off operation is considered necessary, operators should consider reducing the risk of occupant injury in an accident by requiring the wearing of safety helmets by pilots when engaged in emergency training.

The helicopter was overweight during the initial part of the flight, which had structural and performance implications for the flight. Although the overweight condition did not contribute to the accident from a structural standpoint, operating an aircraft over its maximum gross weight increases the risk of structural fatigue, underperformance, and control instability. While the effect of such operations may not be immediately apparent, the cumulative effect of

overweight operations can, over time, be catastrophic.

FINDINGS

From the evidence available, the following findings are made with respect to the collision with terrain involving Robinson Helicopter Company R22 Beta, registered VH-YDA, and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- During flying training, the helicopter impacted the ground with a high rate of descent and significant forward speed, seriously damaging the helicopter and seriously injuring the instructor.
- The instructor was probably struck by a main rotor blade while he was partially outside the cabin during the accident sequence.

Other safety factors

- The pilots were not wearing safety helmets, and were not required to do so.
- The helicopter was fitted with combined seat belt/inertia-reel pilot restraints, with no provision for enhanced upper-body restraint.
- The helicopter was over its gross weight limit during takeoff and in the initial part of the flight, increasing the risk of structural fatigue, underperformance, and control instability.

Other key findings

- The investigation was unable to positively establish why the helicopter collided with terrain.

SOURCES AND SUBMISSIONS

Sources of information

The main sources of information during the investigation included the:

- flight Instructor
- student pilot
- helicopter operator
- Grade 1 Helicopter Instructor/Check Pilot
- Proserpine/Whitsunday Coast Airport

- Bureau of Meteorology.

References

R22 Pilot's Operating Handbook

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the Transport Safety Investigation Act 2003, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the instructor, student pilot, operator, airport manager, helicopter manufacturer and the Civil Aviation Safety Authority.

Submissions were received from the student pilot and the helicopter manufacturer. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.