ACCIDENT

Aircraft Type and Registration:	Robinson R44 Raven II, G-WTWT	
No & Type of Engines:	1 Lycoming IO-540-AE1A5 piston engine	
Year of Manufacture:	2019 (Serial no: 14294)	
Date & Time (UTC):	26 July 2020 at 0904 hrs	
Location:	Herne Bay, Canterbury, Kent	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 3
Injuries:	Crew - 1 (Minor)	Passengers - 2 (Minor)
Nature of Damage:	Substantial	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	53 years	
Commander's Flying Experience:	400 hours (of which 268 were on type) Last 90 days - 3 hours Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

Synopsis

Shortly after takeoff, the pilot realised that the left front door was not properly closed so decided to make a precautionary landing. During the approach the helicopter developed a high rate of descent which the pilot was not able to arrest. The helicopter stuck the ground and rolled over. Three of the occupants sustained minor injuries.

The investigation found the helicopter had made a downwind approach to land and was likely to have entered a vortex ring state. The pilot was not aware he was making a downwind approach.

History of the flight

On the day of the accident the pilot planned to fly the helicopter to a friend's house with his wife and two other friends. On arrival the intention was then to take his friend and their two daughters on a short local flight.

The first flight from Orsett near Thurrock, where the helicopter is kept, to his friend's house near Herne Bay was uneventful (Figure 1). The landing site was located close to Maypole airfield. The pilot had contacted the owner of the airfield the day before and had been advised to make blind calls on the airfield frequency and to remain west of the centreline for noise abatement. The pilot overflew the landing site from the south-west and flew an orbit of the field. The wind was from the south-west so he made a crosswind approach to

the field to remain west of Mayfield. He made blind calls on the frequency but did not hear or see any other traffic.

Figure 1

GPS track of first flight and accident flight
© 2020 Google, Image © SIO, NOAA, U.S. Navy, NGA, GEBCO)

After landing the pilot wound the throttle back to idle but kept the rotors running. The three passengers exited the helicopter whilst the pilot remained at the controls. His friend and their two daughters then boarded the helicopter. The pilot's wife and other friend assisted them getting in and helped them with their seatbelts and headsets. Once the three new passengers were onboard and everyone was clear the pilot took off to the west.

The pilot climbed to 400 ft tracking to the north to remain clear of Maypole. As they were climbing away the pilot noticed that the left front door was not fully closed. There was approximately a half inch gap between the door and the frame. The latch appeared to be in the rear (closed) position but not rotated down. He asked the passenger to push the handle down but it would not move. He then asked the passenger to pull the door inwards and to try to latch it but he inadvertently unlatched the door and it opened 1 to 2 inches which alarmed the passenger. At this stage the pilot decided to make a precautionary landing in a field so he could close the door on the ground.

The pilot selected a suitable large field ahead. He believed he was still heading north and planned to make a crosswind approach on his current heading then turn left into wind when he was lower.

The pilot lowered the collective and established the descent. In the bottom third of the descent the pilot raised the collective to reduce the descent and tried to turn left with the cyclic. However, the helicopter did not turn. As the helicopter descended through 50 ft the pilot tried harder to turn and pulled more and more collective to reduce the rate of descent, but it did not have any effect. The engine appeared to be running and there were no warning lights or unusual vibration.

The helicopter stuck the ground with the right skid first. The skid dug in and the helicopter rolled onto its right side (Figure 2). The pilot and front seat passenger were able to climb out of the left front door and helped the two rear seat passengers exit. Emergency services arrived shortly afterwards.

The pilot and two of the passengers had minor injuries.

Figure 2

G-WTWT after the accident

After the accident, the pilot realised he had inadvertently turned right whilst trying to resolve the door problem and had made the approach track tracking north-east. He thought a possible reason for him being unable to turn was that the passenger may have inadvertently restricted the controls as the dual controls were still fitted. However, the passenger was not aware of having done this.

Accident site

Figure 3 shows the initial impact mark where the right skid dug into the soil causing the helicopter to roll over.

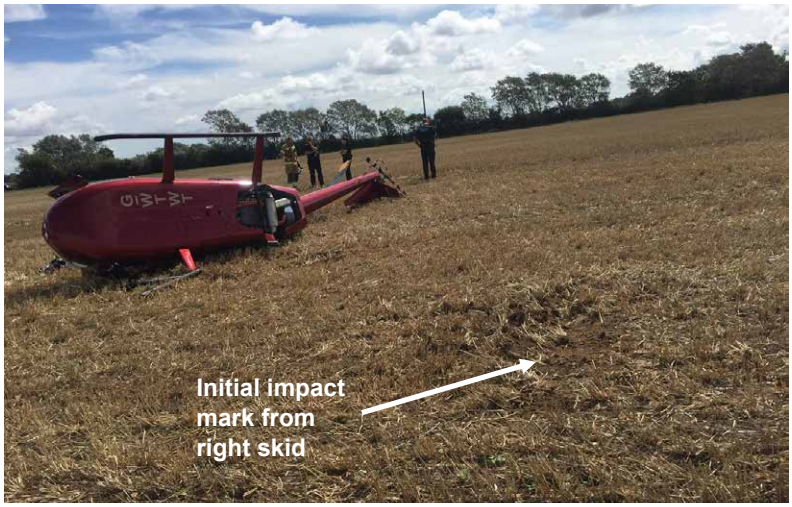

Figure 3

Accident site showing the initial impact mark from the right skid

Meteorology

The general weather conditions in the region at the time of the accident were good. The visibility was greater than 10 km, cloud was scattered at approximately 2,000 ft and the temperature was 18°C.

The surface wind reported at Southend Airport (38 km north-west of accident site) was from 240° at 14 kt at 0850 hrs and from 250° at 10 kt at 0920 hrs. At 0900 hrs the surface wind at Shoeburyness (30 km south-west) was from 270° at 11 kt and at Manston (15 km east) it was from 240° at 12 kt.

The UK low-level spot wind chart forecast the 1,000 ft wind in the region to be from 260° at 20 kt (between 0300 hrs and 0900hrs) and from 270° at 20 kt (between 0900 hrs and 1500 hrs).

Recorded information

The pilot was using a flight planning and navigation app on a tablet computer which recorded the accident flight. Figures 4 and 5 show the helicopter's track downloaded from the tablet. The orbit around the first landing site can be seen in the figures to the west of Mayfield. The helicopter reached a GPS altitude of 746 ft above the landing field elevation.

Figure 6 shows the data extracted. The helicopter's heading as it approached the ground was approximately 070°. The groundspeed reached a maximum of 107 kt then reduced steadily during the descent. Table 1 shows the helicopter's rate of descent, groundspeed and estimated airspeed as it descend below 100 ft. The airspeed has been estimated assuming a 10 kt tailwind.

Height above the ground (ft)	Ground-speed (kt)	Estimated airspeed (kt)	Derived Rate of descent (ft/min)	Heading (degrees)
98	31	21	914	070
78	26	16	1,186	070
58	23	13	1,192	069
36	21	11	1,344	066
14	19	9	1,271	064

Table 1

GPS data as the helicopter descended through 100 ft

Figure 4

Accident flight showing altitude profile
(© 2020 Google, Image © SIO, NOAA, U.S. Navy, NGA, GEBCO)

Figure 5

Accident flight ground track orientated north up
(© 2020 Google, Image © SIO, NOAA, U.S. Navy, NGA, GEBCO)

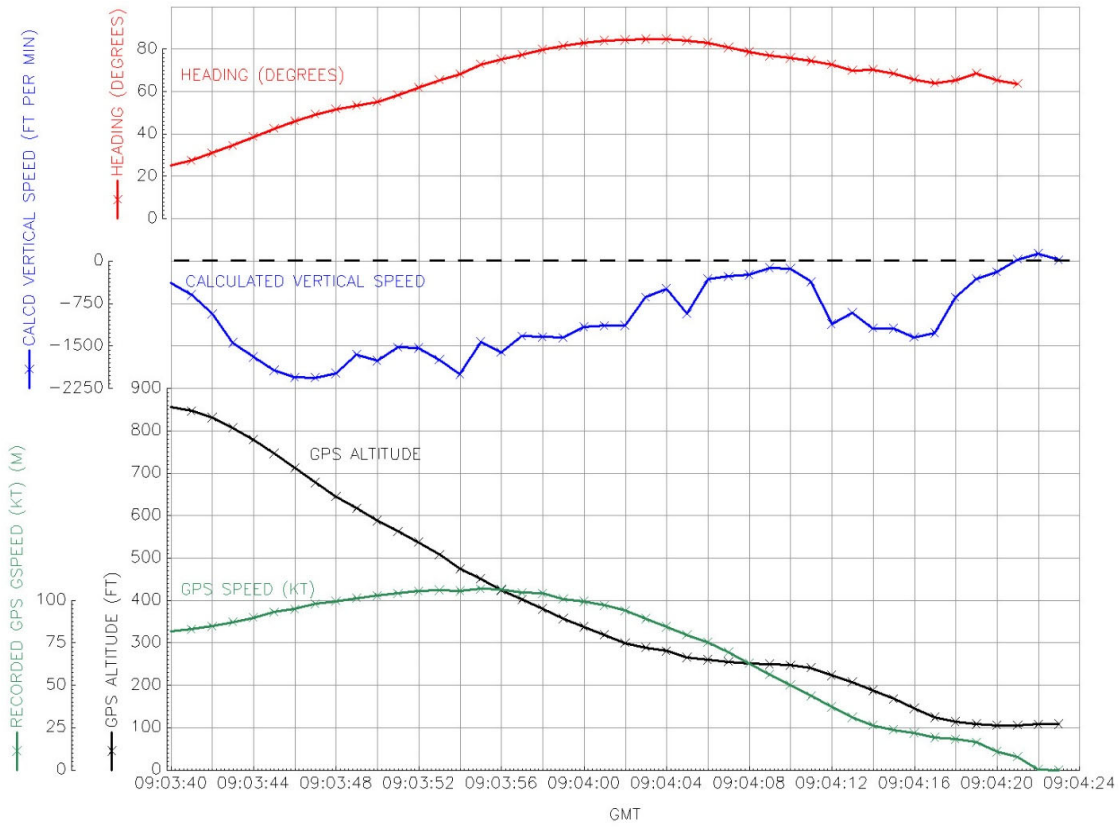

Figure 6

GPS data from last part of accident flight

Vortex ring state[1]

Vortex ring state describes an aerodynamic condition which results in a sudden loss of rotor thrust and a subsequent rapid loss of height.

Although vortices are always present around the periphery of the rotor, under certain airflow conditions the vortices will intensify and, coupled with a stall spreading outwards from the root end of the blade, result in a sudden loss of rotor thrust. This is known as a vortex ring state. It can be entered from several inflight manoeuvres but the airflow conditions which cause it remain substantially the same. It will only occur when all the following are present:

- Power is applied to the rotor (giving an induced flow down through the rotor disc),
- There is a high rate of descent (giving an external airflow opposing the induced flow),
- The indicated airspeed is low.

Footnote

[1] Bailey, N. (2008) The helicopter pilot's manual: Principles of flight and helicopter handling. Marlborough: Airlift Publishing.

These conditions can occur whilst making a downwind approach. If the rate of descent is too high and the airspeed is allowed to reduce significantly the helicopter can encounter vortex ring.

Once in a vortex ring state the controls become significantly less responsive due to the reduced length of rotor blade that is producing thrust and therefore able to respond to control inputs.

Analysis

Shortly after takeoff the pilot became aware that the left front door was not fully closed. The passenger was unable to close the door in flight so the pilot made the decision to make a precautionary landing. Whilst trying to instruct the passenger to close the door the pilot did not notice that the helicopter had turned to the east and was heading downwind. The pilot did not realise that he was making a downwind approach to the field.

As the helicopter descended below 100 ft the rate of descent was greater than 1,000 ft/min and the airspeed dropped below 15 kt. It is likely that the helicopter started to enter a vortex ring state. This would explain why the helicopter did not respond to increasing collective and did not turn left with cyclic input. The pilot did not recognise the helicopter was entering vortex ring so did not apply corrective action.

The pilot suggested that it is also possible that the passenger had inadvertently restricted the controls as the dual controls were still fitted.

The accident highlights the hazard of passengers boarding with rotors running where it is harder for the pilot to confirm all doors are properly closed. It also demonstrates how easy it is for a pilot to be distracted from the primary task of flying the aircraft when a minor problem occurs in flight.

Conclusion

The pilot decided to make a precautionary landing when he became aware that a door was not properly closed. However, he inadvertently made a downwind approach. During the later stage of the decent it is likely that the helicopter started to enter a vortex ring state leading to a high rate of descent which the pilot was not able to arrest.