ACCIDENT

Aircraft Type and Registration:	Pierre Robin R2100A, G-BICS
No & Type of Engines:	1 Lycoming O-235-H2C piston engine
Year of Manufacture:	1977 (Serial no: 128)
Date & Time (UTC):	6 May 2018 at 1100 hrs
Location:	Eaton Bray Farm Airfield, Bedfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Substantial
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	876 hours (of which 274 were on type) Last 90 days - 7 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During takeoff, the aircraft did not attain flying speed and collided with a hedge at the far end of the runway. Performance calculations by the AAIB indicated that, although the ground run required was less than the runway length available, the takeoff distance required exceeded the takeoff distance available.

History of the flight

The pilot reported that he had planned a flight with a passenger from his home base at Eaton Bray Farm Airfield, Bedfordshire to Sandown Airport, Isle of Wight.

The pilot decided to use Runway 29, although it would involve a slight tailwind, as it would be away from buildings close to the threshold of the runway. After completing his checks, the pilot commenced the takeoff roll. The aircraft reportedly reached an airspeed of 40 kt approximately 400 m along the runway, but its acceleration did not continue as expected. The aircraft collided with a 2 m (6.6 ft) high hedge at the far end of the runway at an estimated airspeed of 45 kt. (The rotate speed for this aircraft is 49 kt and the best climb angle speed is 62 kt.) Both occupants, who were wearing four-point harnesses, were uninjured and able to vacate the aircraft unaided. The aircraft was substantially damaged, (Figure 1).

Figure 1
General view of the aircraft post-accident

The pilot commented that the engine was being operated on condition and, although worn, it appeared to be developing its normal engine speed for takeoff of 2,300 rpm on the day. The aircraft's flight manual states that maximum takeoff engine power is achieved at 2,600 rpm; the minimum engine speed for takeoff is 2,300 rpm.

Previous experience gained over 5 years and 250 takeoffs from the strip had led the pilot to become used to the aircraft's marginal takeoff performance. His normal procedure was to "pull" the aircraft into ground effect and accelerate away.

Later inspection by the pilot revealed that the flaps were fully extended, rather than being set for takeoff. The flaps are usually fully extended when the aircraft is parked, as this allows the occupants easier access to the cockpit. During checks prior to takeoff, the flaps are normally retracted to the TAKEOFF position. The pilot suggested that this omission may have been due to the distraction of having a passenger onboard.

Weather information

The weather conditions were reported as good; the wind was from the south-east at 0 to 2 kt and the temperature was 20 to 22ºC.

Weight and Balance information

The pilot's weight and balance calculations indicated that the aircraft was "heavy" but loaded within limits.

Airfield information

The runway is orientated 29/11 and has a grass surface. Its condition was reported as dry and newly rolled. The farm's website states the runway length is 600 yards (549 m). The pilot reported that he had measured the strip and found it to be 615 m long. Measurements taken from aerial imagery of the airfield more closely match the length stated on the farm's website. Adjacent to the Runway 29 threshold and under the approach path are a parking area and hangars, (Figure 2).

Figure 2

View of Eaton Bray Farm Airfield indicating runway length

Aircraft performance

The aircraft flight manual provides performance information when using a dry, hard runway, full throttle and flaps set to the TAKEOFF position. Data to account for various weights, headwind speeds and elevations is included. It also notes that the distance needs to be increased by 8% for every 10ºC increase in temperature above standard at the altitude concerned and by a further 8% when using a dry grass runway. No factor was stated for a tailwind, but CAA Safety Sense Leaflet 7c, '*Aircraft Performance*', recommends adding 20% for a tailwind component of 10% of the lift off speed. The leaflet also recommends that at least 150% of the tailwind component of the reported wind be used. As this aircraft's lift off speed is 49 kt, for every 5 kt of tailwind an extra 20% should be added to the takeoff distance required.

For the accident flight, and using the appropriate additional factors, the takeoff distance required to clear 50 ft was calculated to be 2,112 ft, or 644 m. The CAA also strongly recommends that an additional safety factor of 1.33 be used to account for a number of factors including: aeroplane/engine wear and tear and less than favourable conditions or technique. Using this additional safety factor, the takeoff distance required to reach 50 ft was 856 m (Figure 3 and Table 1).

Flight Manual R 2100 A

Avions Pierre Robin

Take-off performance		Dry, hard runway Flaps : T/O - Full throttle					
Max. weight	Front wind (kts)	S.L. - + 15°C (ft)		2500 ft - + 10°C (ft)		5000 ft - + 5°C (ft)	
		Run	50' clear	Run	50' clear	Run	50' clear
775 kg 1708 lbs	0 10 20	985 800 640	1790 1490 1200	1200 985 770	2200 1840 1475	1475 1215 950	2705 2265 2050
750 kg 1655 lbs	0 10 20	870 720 560	1590 1330 1065	1065 885 690	1970 1640 1330	1330 1100 870	2410 2020 1820
700 kg 1545 lbs	0 10 20	720 590 475	1310 1100 885	885 740 575	1610 1345 1085	1085 885 705	1985 1655 1330

NOTE : 1 - Increase distances by 8% for every 10°C increase of the standard temperature, at the altitude concerned.
2 - Take-off from dry grass runway. : increase distances by 8%.

1ft = 0.3048 m

dition 1 - Nov 1977

Figure 3

Extract from aircraft flight manual

Parameter	Reported value	Factor	Distance required
Takeoff weight	758 kg	from flight manual (sea level assumed)	1,654 ft
Temperature	22ºC	plus 8% per 10ºC above standard - 7ºC above standard = plus 5.6% (x 1.056)	1,747 ft
Surface	Dry grass	plus 8% (x 1.08)	1,886 ft
Headwind / Tailwind	2 kt Tailwind (lift off speed 49 kt)	CAA Safety Sense 7c, use 150% of reported tailwind, add 20% for tailwind of 10% lift off speed - 3 kt tailwind = plus 12% (x 1.12)	2,112 ft or **644 m**
Plus safety factor for **takeoff distance required**		plus 33% (x 1.33)	2,809 ft or **856 m**

Table 1

Summary of takeoff performance calculation

Information is also provided in the flight manual to calculate the ground run required. Using the same parameters and additional factors, a ground run of 470 m was calculated.

Other information

The CAA Safety Sense Leaflet 7c, '*Aeroplane Performance*'[1], includes useful information to assist a pilot in assessing if the proposed flight can be safely made. It discusses where to find and how to use performance data, performance planning and general points that may affect aircraft performance. It also includes a useful and easy to use summary of these factors and how they affect performance (Figure 4). The leaflet also discusses the importance of having a decision point so that a pilot can safely abandon a takeoff if the aircraft performance is not as expected. Similar information can also be found in UK Aeronautical Information Circular (AIC) 127 /2006 (Pink 110) '*Take Off, Climb and Landing Performance of Light Aeroplanes*'[2] and in the CAA's '*Skyway Code*'[3].

This leaflet also notes that the performance figures used in the flight manual are those achieved by the manufacturer using a new aeroplane and engine in ideal conditions flown by a highly experienced pilot (Figure 4).

Effect of flap on takeoff performance

An appropriate flap setting can be used to optimise an aircraft's takeoff performance, but only flap settings that are specified in the aircraft flight manual should be used.

For some aircraft, a greater flap setting can be specified for 'short' or 'soft' field takeoffs to minimise the ground roll. The increased lift from the increased flap setting allows the aircraft to become airborne at a lower speed, but the increased drag once airborne can degrade climb performance and therefore obstacle clearance.

For lower powered aircraft and/or those with large flaps, the use of a flap setting greater than the specified takeoff setting can mean that once airborne, the increased drag is such that the aircraft is no longer able to climb.

The drag due to flap extension during the ground roll is small until rotation speed. When the aircraft is rotated nose-up to lift-off it increases significantly.

Analysis

The aircraft had its flaps in the fully extended position when the takeoff commenced. Although this was the incorrect position, it would have only had a small effect on the aircraft's acceleration whilst it was on the ground. Had it reached rotation speed, it is likely that the increased drag once airborne would have resulted in the aircraft not being able to accelerate further or climb out of ground effect.

Footnote

1 CAA Safety Sense Leaflet 7c can be found on the CAA's website http://publicapps.caa.co.uk/docs/33/20130121SSL07.pdf (accessed September 2018)

2 AIC 127/2006 can be found on the National Air Traffic Services (NATS) Aeronautical Information Service website http://www.ead.eurocontrol.int/eadbasic/pamslight-4119FE5438D1533E8F16B68C6D5E4401/7FE5QZZF3FXUS/EN/AIC/P/127-2006/EG_Circ_2006_P_127_en_2006-12-07.pdf (accessed September 2018)

3 The CAA's Skyway Code can be found on the CAA website https://www.caa.co.uk/General-aviation/Safety-information/The-Skyway-Code/ (accesssed September 2018)

The aircraft weight was towards its maximum weight, but within loading limits. A performance calculation, using the aircraft's weight and the conditions at the time, indicated that a minimum of 644 m was required to reach a height of 50 ft. When the recommended safety factor was added the takeoff distance required was 856 m, of which the ground run was 470 m. The aircraft did not reach its rotation speed of 49 kt and the pilot's unsuccessful attempt to 'pull' the aircraft into ground effect would have increased drag resulting in reduced acceleration.

10 SUMMARY:

FACTORS MUST BE MULTIPLIED e.g. 1.20 x 1.35

	TAKE-OFF		LANDING	
CONDITION	INCREASE IN TAKE-OFF DISTANCE TO HEIGHT 50 FEET	FACTOR	INCREASE IN LANDING DISTANCE FROM 50 FEET	FACTOR
A 10% increase in aeroplane weight, e.g. another passenger	20%	1.20	10%	1.10
An increase of 1,000 ft in aerodrome elevation	10%	1.10	5%	1.05
An increase of 10°C in ambient temperature	10%	1.10	5%	1.05
Dry grass* - Up to 20 cm (8 in) (on firm soil)	20%	1.20	15%+	1.15
Wet grass* - Up to 20 cm (8 in) (on firm soil)	30%	1.3	35%+ Very short grass may be slippery, distances may increase by up to 60%	1.35
Wet paved surface	-	-	15%	1.15
A 2% slope*	Uphill 10%	1.10	Downhill 10%	1.10
A tailwind component of 10% of lift-off speed	20%	1.20	20%	1.20
Soft ground or snow*	25% or more	1.25 +	25%+ or more	1.25 +
NOW USE ADDITIONAL SAFETY FACTORS (if data is unfactored)		**1.33**		**1.43**

Notes:
1. * Effect on Ground Run/Roll will be greater. Do not attempt to use the factors to reduce the distances required in the case of downslope on take-off or upslope on landing.
2. + For a few types of aeroplane (e.g. those without brakes) grass surfaces may decrease the landing roll. However, to be on the safe side, assume the INCREASE shown until you are thoroughly conversant with the aeroplane type.
3. Any deviation from normal operating techniques is likely to result in an increased distance.

If the distance required exceeds the distance available, changes will HAVE to be made.

Figure 4

Extract from CAA Safety Sense Leaflet 7c

Although the ground run required, including the safety factors, was less than the runway length, it does not account for the distance taken for the aircraft to accelerate to its climb speed and climb. The standard takeoff distance required to 50 ft (TODR) takes this into account and allows for the acceleration phase and an initial climb to clear a 50 ft obstacle. It is worth noting that the standard 50 ft height used is less than two wing spans for this and many common general aviation aircraft.

The pilot had previously measured the runway as 615 m long, but information provided on the farm's website indicated it was 600 yards (549 m) long. Measurements taken from a satellite image of the airfield more closely match the length stated on the farm's website. These measurements were all less than the minimum takeoff distance required for the aircraft's weight and the conditions on the day.

The pilot candidly commented that he had become used to the aircraft's marginal performance from this airfield. The engine was operating on condition and the engine speed achieved of 2,300 rpm, the minimum required for takeoff, indicated the engine was worn. As a result the aircraft's performance on the day would have been less than the figures shown in the flight manual which were recorded with a new aircraft and engine in ideal conditions.

Despite recognising that the aircraft's performance was not as expected, the takeoff was continued until the aircraft struck a 2 m high hedge at the far end of the runway.

Conclusion

During takeoff the aircraft failed to become airborne and struck a hedge at the far end of the runway. Performance calculations by the AAIB indicated that although the ground run required was less than the runway length available, the takeoff distance required to reach 50 ft exceeded the takeoff distance available.

The performance figures used in the flight manual are those achieved by the manufacturer using a new aeroplane and engine in ideal conditions flown by a highly experienced pilot. In this case, the worn engine and the unsuccessful attempt to pull the aircraft in to ground effect would have further reduced the aircraft's performance.

The inadvertent selection of full flap would have had a small effect on the aircraft's acceleration whilst it was on the ground. However, had the aircraft become airborne it would have led to a significant reduction in climb performance.

Discussion and AAIB comments

When calculating aircraft performance, it is recommended that the takeoff distance required to reach 50 ft (TODR) figures are used rather than the ground run figures. The ground run is the minimum distance required for the aircraft to become airborne and it does not include the distance required for the aircraft to accelerate to climb speed and commence its climb.

Any additional factors that are quoted in a flight manual should be considered as the minimum acceptable and more conservative factors, if used, give greater margins of safety.

It is strongly recommended that additional safety factors, like those required for commercial flights, be used to take account of aeroplane/engine wear and tear, less than ideal techniques and less than favourable conditions. CAA Safety Sense Leaflet 7c provides an easy to use table which summarises these additional factors, (Figure 4).

In addition to ensuring that the aircraft performance is sufficient, it is recommended that prior to commencing a takeoff the pilot has a clear decision point in mind from which the takeoff can be safely stopped in case of any anomalies. Any subsequent lack of performance, for whatever reason, should then be more easily recognised and allow the takeoff to be safely abandoned.

Before commencing any takeoff, care should be taken to ensure the aircraft is correctly configured.