ACCIDENT

Aircraft Type and Registration:	Pierre Robin HR100/200B, G-CBFN
No & Type of Engines:	1 Lycoming IO-360-A1D6 piston engine
Year of Manufacture:	1971
Date & Time (UTC):	29 May 2005 at 1651 hrs
Location:	Blackbushe Airport, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 Passengers - N/A
Nature of Damage:	Damage to right wing leading edge, nose landing gear and nose structure
Commander's Licence:	Private Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	163 hours (of which 34 were on type) Last 90 days - 4 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, further enquiries by the AAIB and metallurgical examination

The aircraft had completed a flight to Perranporth where the landing was uneventful, as was the subsequent taxiing and airborne portion of the return flight. The pilot reported that following a normal approach to Runway 25 at Blackbushe, with a speed of between 85 and 90 kt, flaps 1 selected, and calm wind, the aircraft touched down normally. However, when the pilot applied the brakes he felt no retardation and asked the passenger to assist him in applying brake pressure, which again had no effect. Around 200 m before the end of the runway he made an RT transmission stating 'brake failure'. By this time he judged it was too late to perform a go-around and the aircraft overran the end of the runway coming to rest on a small bank in amongst some gorse bushes. Both the pilot and passenger exited the aircraft unaided.

The Air Traffic Controller reported the aircraft seemed fast on final approach and touched down on Runway 25, which has a published landing distance available (LDA) of 1,058 m, 200 m beyond the threshold. No debris was found on the runway at Blackbushe.

Brake description and maintenance requirements

This type of aircraft is fitted with hydraulically operated disk type brakes on both main wheels. Brake pressure is applied via a floating cylinder assembly to compress the brake pads against the rotating disks (Figure 1). The manufacturer's approved brake pads consist of a backing plate to which friction material (Flertex 379) is bonded using Redux 64 adhesive. In 2001, a modification was introduced following instances where the friction

material had become disbonded from the backing plates. The modification required the additional use of rivets to ensure attachment of the friction material to the backing plate (ref Robin Aviation drawing number 41-22-16).

The aircraft was maintained to the CAA Light Aircraft Maintenance Schedule (LAMS) ref CAA/LAMS/A/1999. The general inspection standards applied to individual inspection tasks must meet the recommended standards and practices of the organisation responsible for the type design and are normally published in maintenance manuals. The general inspection standard in LAMS requires the inspection of the landing gear including brake system, brake linings, drums/discs, wheels and tyres to be completed every 50 flying hours or 6 months whichever is the sooner. There is also a requirement for a pre-flight inspection of the 'brake installation for external evidence of leaks, and for damage and security'.

This aircraft was fitted with 'spats' covering the wheels and brakes, which made any pre-flight inspection of the condition of the brakes difficult.

Brake examination

The brakes were examined by the AAIB following the aircraft's recovery to a repair agency and subjected to further metallurgical examination at QinetiQ. Examination showed extensive damage to both sets of brake pads; the inboard (piston side - see Figures 2 & 3) backing plate of each brake exhibited evidence of metal smearing and material build-up towards one edge. There was some evidence of small amounts of friction material remaining on the backing plates along the edges at the inner radius of contact on the brake disc (Figures 2 and 3), and there was also evidence of deformation of the backing plates themselves.

Figure 1

Landing gear showing brake piston, disc and pads

The backing plates on the outboard side similarly showed extensive wear marks but did not show the material build-up. There was however evidence of corrosion around the outer edges of the backing plates. There was no evidence of any friction material being present.

Sections were taken through the edge of each backing plate and examined in a Scanning Electron Microscope (SEM), they showed that

> *'a thin surface layer approximately 40 µm thick was present, which energy dispersive x-ray (EDX) analysis showed to consist of iron and oxygen. It was also observed that the surface layer showed evidence of spalling.'*

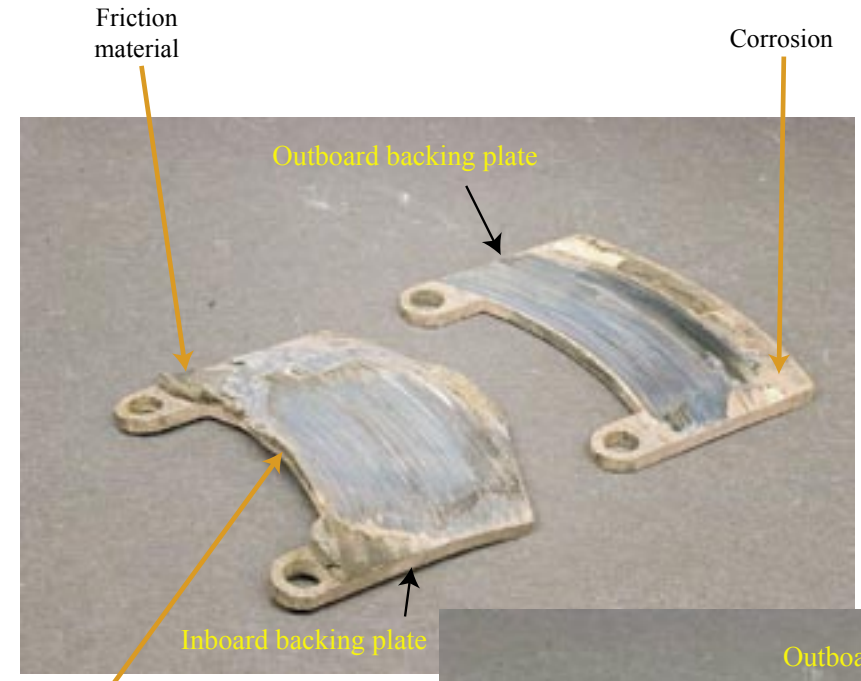


Figure 2
Brake pads (left)

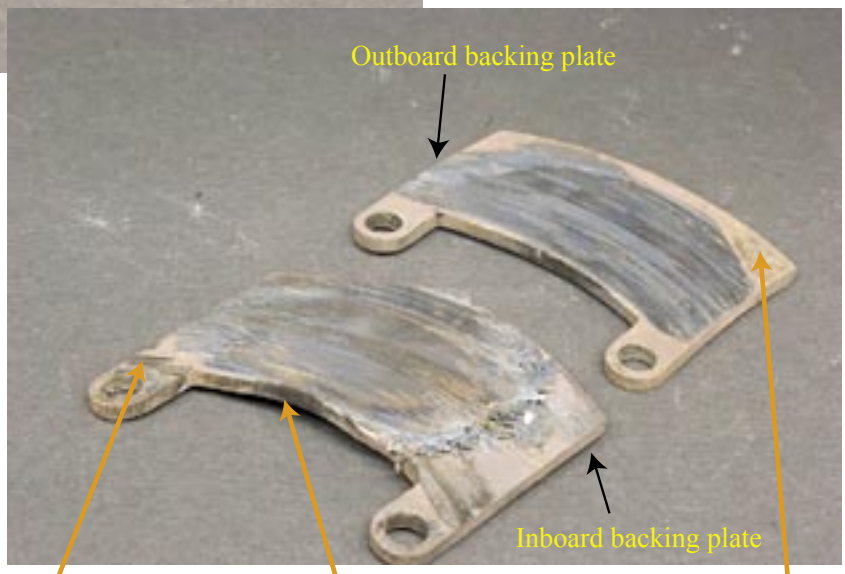


Figure 3
Brake pads (right)

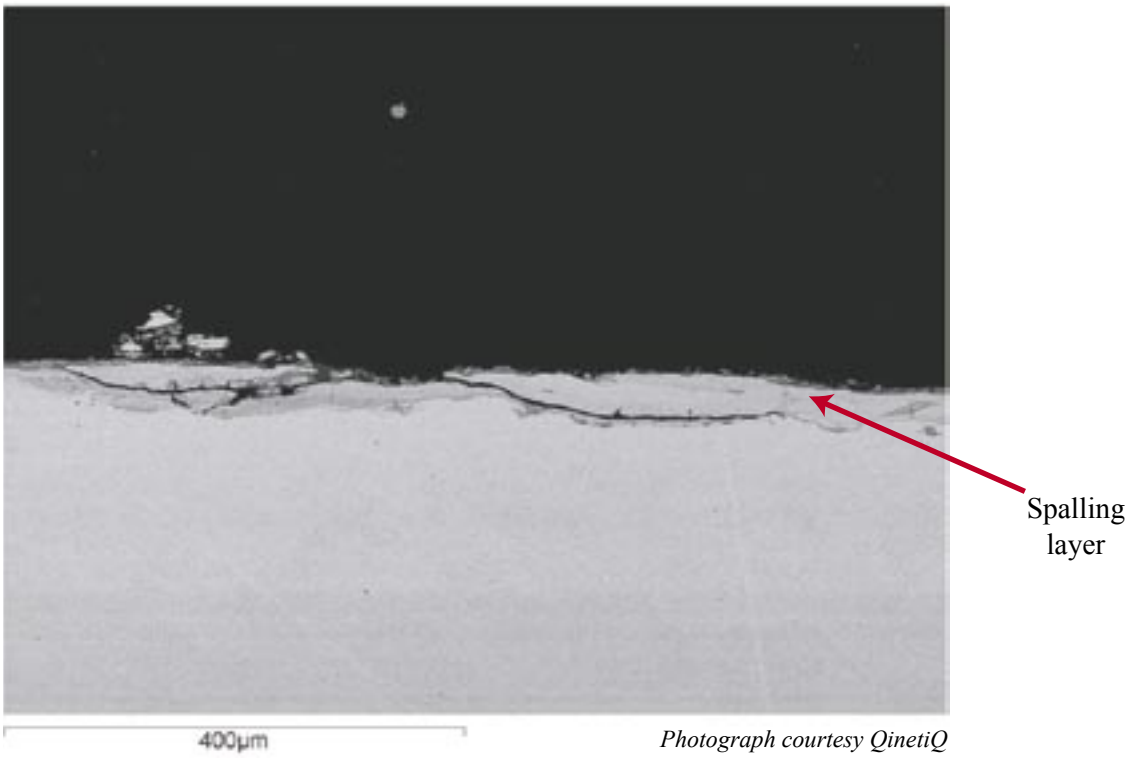
Photographs courtesy QinetiQ

Spalling describes the flaking of a surface where cracks run parallel to the surface, in this case due to the oxide layer (see Figure 4). They found

> *'where the material build-up was more pronounced, the analysis showed similar evidence of iron and oxygen present indicating that the material-build up consisted of the pad backing material.'*

A section through the remaining area of friction material

> *'showed evidence of cracking within the friction material and surface oxidation on the surface of the backing plate.'*



Photograph courtesy QinetiQ

Figure 4

Cross Section through a smooth area of the right inner backing plate

There was a bond layer

> *'approximately 40 µm thick with the friction material appearing to be well bonded to it. A layer of surface oxide was present between the backing plate and bond layer approximately 7 µm thick, which appeared to have separated from the backing plate. This indicates that the friction material was not bonded to the backing plate in this area.' (see Figure 5)*

The report on the metallurgical examination of the brake pads concluded

> *'that very little of the friction material was present. The majority of the pads showed evidence of material removal and oxidation most likely from contact with the brake discs. The majority of the oxidation that was observed appeared to be blue in colour, which suggests thermal oxidation, as opposed to atmospheric corrosion. The oxidation is likely to have resulted from overheating of the pads during braking as the backing material was contacting the discs, overheating could also account for the distortion that was observed in two of the pads. Where small sections of friction material remained, examination showed that it was bonded to an oxide layer that was present on the surface of the backing plate. In some areas the oxide layer had separated from the backing plate, resulting in the friction material no longer being bonded.*
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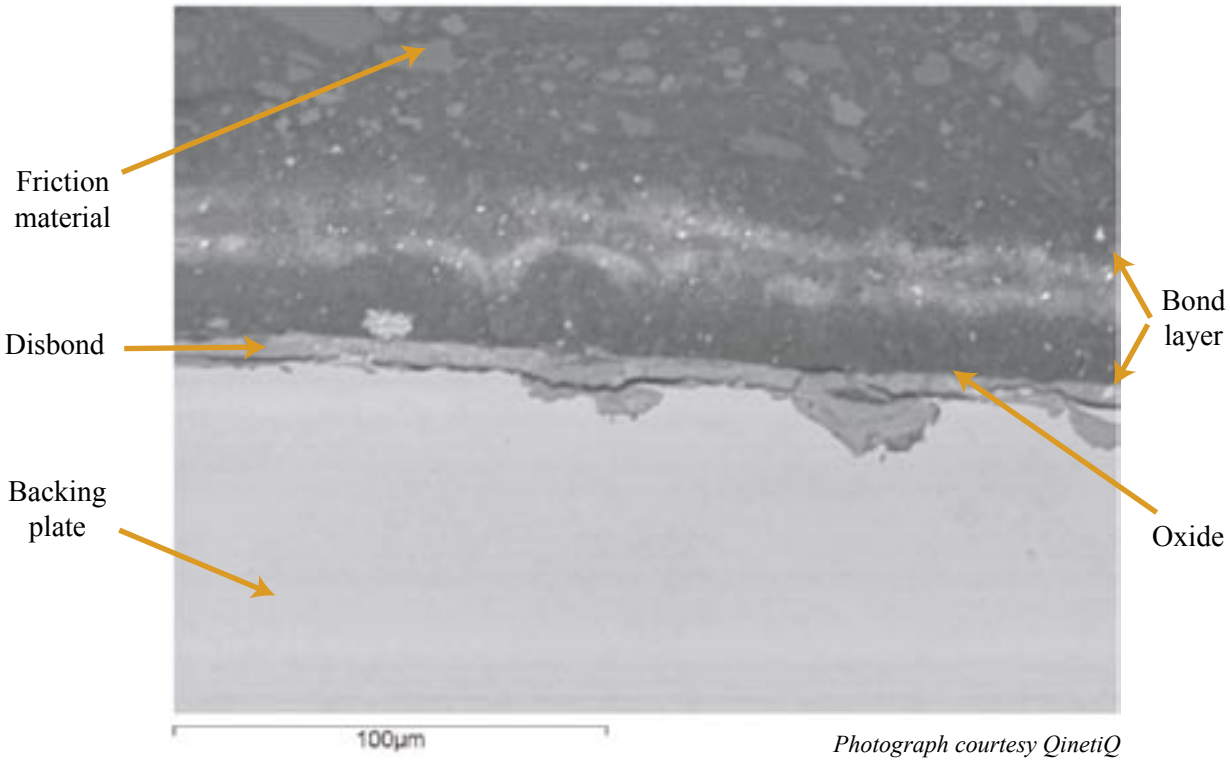
> *The cause of the brake pad failure can not be positively identified due to the lack of evidence remaining. The small sections of friction pad that did remain showed evidence of the friction*



Photograph courtesy QinetiQ

Figure 5

Cross Section through the bond line of the right inner backing plate

material being bonded to the oxidised surface of the backing plate, which suggests that the pad was not adequately cleaned before bonding. Evidence of surface corrosion was observed on pads, which could also be indicative of the surface condition prior to bonding.

The sections of friction material that did remain showed evidence of wear on the surface, which suggested that the pads had worn down at these points, as opposed to the friction material disbonding and spalling. As the majority of the backing plate material showed evidence of wear, it is not known if the friction material in these areas had worn or disbonded. However, the available evidence suggests that the friction material was bonded to an oxide layer on the backing plates, which could cause a weak bond. Sections of the friction material may have disbonded causing the remaining areas to wear a lot faster than normal due to the increased work load during braking.'

Brake history

The aircraft had a Certificate of Airworthiness in the Transport (Passenger) category and was operated by a group of pilots. In June 2004 the brake pads and right brake disc were replaced at the annual check having been found to be 'worn to limits' with metal to metal contact between the pad backing plates and the discs. Subsequently, the group reported an 'immediately noticeable drop in braking performance'; and the aircraft later suffered an overrun from the end of a runway into a flat field. There was no damage to the aircraft on this occasion. However, the pilot reported that the brakes had given 'poor braking effect'. The brakes would hold against a static load, but seemed poor

when applied during the landing roll. Following the overrun incident the aircraft the brakes were checked and reported as satisfactory.

In September 2004, at the next 50 hour check, the brakes were reported as 'not being 100%'. The brakes were examined and the maintenance agency reported 'brakes rectified'.

The most recent maintenance on the brakes was during a 50 hour check carried out in March 2005; prior to this the brakes had again been reported as 'not being 100%'. The maintenance agency examined the brakes and their Worksheet states 'replace, re-line and refit' the pads, following which the aircraft was test flown and the brake system was reported to be satisfactory. The maintenance organisation indicated that approved manufacturer's pads were not readily available, not being held in stock by their aircraft parts supplier, and had sent the pads to the supplier to be re-lined. The relining had been performed by an automotive supplier; the process involved the use of '416' industrial material which was bonded to the existing backing plate using 'Bostik 177' and heat treated to 300ºC. The pads were not riveted.

At the time of the accident the aircraft had flown approximately 30 hours since the maintenance input.

Brake relining

Relining of brakes is not uncommon, particularly on aircraft where approved parts are not available. The CAA does not publish any advice on the relining of brakes. General guidance and advice on wheels and brakes is published in CAP 562 CA AIP leaflet 5-8. This supplements the manufacturer's information published in their maintenance manual. The replacement of brake pads and the parts to be used would need to be those specified in the manufacturer's manuals. Relining would be classified as a repair and, if permitted, would need to be carried out in accordance with approved repair data, normally specified in the maintenance manual. It is recognised that, owing to the inflexibility of the brake lining material, a poor bond is likely to be achieved if an attempt is made to reline a distorted backing plate. It could not be established whether the backing plates in this instance, were distorted before relining or during this event.

No approval for relining the brake pads had been given by the manufacturer of this aircraft type, nor, given their experience of pad disbonding in other incidents would they have given approval for relining using only adhesive to attach the friction material to the backing plates.

Discussion

The landing distance available on Runway 25 at Blackbushe is quite adequate for this type of aircraft, which typically requires a landing roll of less than 400 m. The runway also has 3.1º PAPIs available for approach path assistance on request. Consequently the major reason for the aircraft overrunning is considered to be misjudgement of the approach to land. Approaches misjudged to varying degrees are not particularly unusual in General Aviation, however, and it would be reasonable for pilots to have an expectation of normal aircraft braking performance.

There was a history of braking problems on this aircraft which had already resulted in one overrun incident. The brakes were checked at the 50 hour interval specified in LAMS but it was difficult for the group to routinely monitor brake wear as the aircraft was fitted with spats. The pilot on this incident reported no braking problems on the previous flight, or while taxiing prior to the accident flight. The nature of the damage to the brake pads is consistent with hydraulic pressure operating to

apply pressure to the pads; the evidence indicates that a large amount of heat energy was generated by the friction between the pads and the discs. However, there was little retardation of the aircraft.

It was not possible to determine whether the incident resulted from disbonding of significant amounts of friction material, or simply from an absence of material due to excessive wear. However, the metallurgical examination did produce evidence that the friction material had been bonded to an oxide layer on the backing plates, which could have caused a weak bond. There was no evidence of debris on the runway at Blackbushe.

The brake pads fitted to G-CBFN were not manufacturer's approved parts. The manufacturer had introduced the new standard of bonded and riveted pad in 2001 due to an in service problem of brake friction material disbonding from the backing plates. However, this change had not been communicated to owners and maintenance agencies, some of whom were not aware of the new standard.

Safety Recommendation 2005-145

It is recommended that Apex Aircraft, the Manufacturer and Type Certificate holder for Robin aircraft types, issues appropriate information to owners and maintenance organisations regarding the revised standard of brake pads with bonded and riveted friction material and clarify the acceptability of fitting brake pads which have been relined.