

ACCIDENT

Aircraft Type and Registration:	Beech 200 Super Kingair, G-BGRE	
No & Type of Engines:	2 Pratt & Whitney Canada PT6A-61 turboprop engines	
Year of Manufacture:	1979	
Date & Time (UTC):	23 November 2009 at 1308 hrs	
Location:	Chalgrove Airfield, Oxfordshire	
Type of Flight:	Private	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Aircraft nose and propellers damaged	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	47 years	
Commander's Flying Experience:	7,000 hours (of which 600 were on type) Last 90 days - 60 hours Last 28 days - 22 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot, operator's investigation report and metallurgy report	

Synopsis

Following retraction of the landing gear after takeoff, the red gear unsafe warning light remained ON. When attempting to extend the gear again at the end of the flight, the nose landing gear did not fully deploy. When the aircraft landed the nose gear collapsed, causing damage to the aircraft nose and propellers, but no injuries to the occupants. The nose gear drive chain was subsequently found to have failed in overload.

History of the flight

The aircraft was returning to Chalgrove from Langford Lodge in Northern Ireland. Following retraction of the gear after takeoff, the red gear unsafe warning light remained ON. The crew flew the remainder of the flight

at less than 181 KIAS as a precaution. During the final stages of the flight, the crew selected the landing gear lever to the DOWN position. This resulted in both main landing gear legs extending, with their associated green lights indicating they had locked in place. However, the green light for the nose gear remained OFF and the red gear unsafe warning light illuminated, indicating that the nose landing gear had not locked down.

The pilot flew a low pass over the airfield and observers on the ground confirmed that the nose landing gear had not fully extended. The pilot decided to continue with the landing, anticipating that the nose gear might collapse as it started to support the aircraft's weight. He

then conducted a normal approach, but shut down both engines just prior to touchdown of the nose gear. During the landing roll the nose gear leg collapsed, causing both propellers to strike the ground. The aircraft eventually came to a stop resting on its nose, just off the runway centreline. Both occupants were uninjured and vacated the aircraft through the main passenger door.

Landing gear system description

The landing gear system has a gearbox located below the cabin floor, in the centre of the fuselage. The gearbox is operated by an electric motor which is controlled by the landing gear lever position. There are three outputs from the gearbox: spine drives attached to torque tubes which turn each main gear leg actuator, and a sprocket that drives a duplex chain turning the nose gear leg actuator. The electric motor has a dynamic brake system which is triggered by microswitches to prevent over-travel of the gear legs. The emergency extension system consists

of a manually operated handle in the cockpit, turning a separate chain attached to the gearbox to drive all three gear legs down together.

Investigation findings

After removing the cabin floor to access the gearbox, it became evident that the nose gear chain had separated. The point of separation was a connecting master link used to remove the chain for maintenance. The pins, plates and the spring clip which made up this link had detached, but the parts were recovered from the aircraft. The chain was visually inspected in accordance with the manufacturer's Aircraft Maintenance Manual (AMM) and the general condition was considered to be within limits. Detailed inspection of the detached parts showed that one of the pins had fractured at its mid point and two of the connecting plates were distorted upwards, with a third plate distorted outwards (Figure 1).

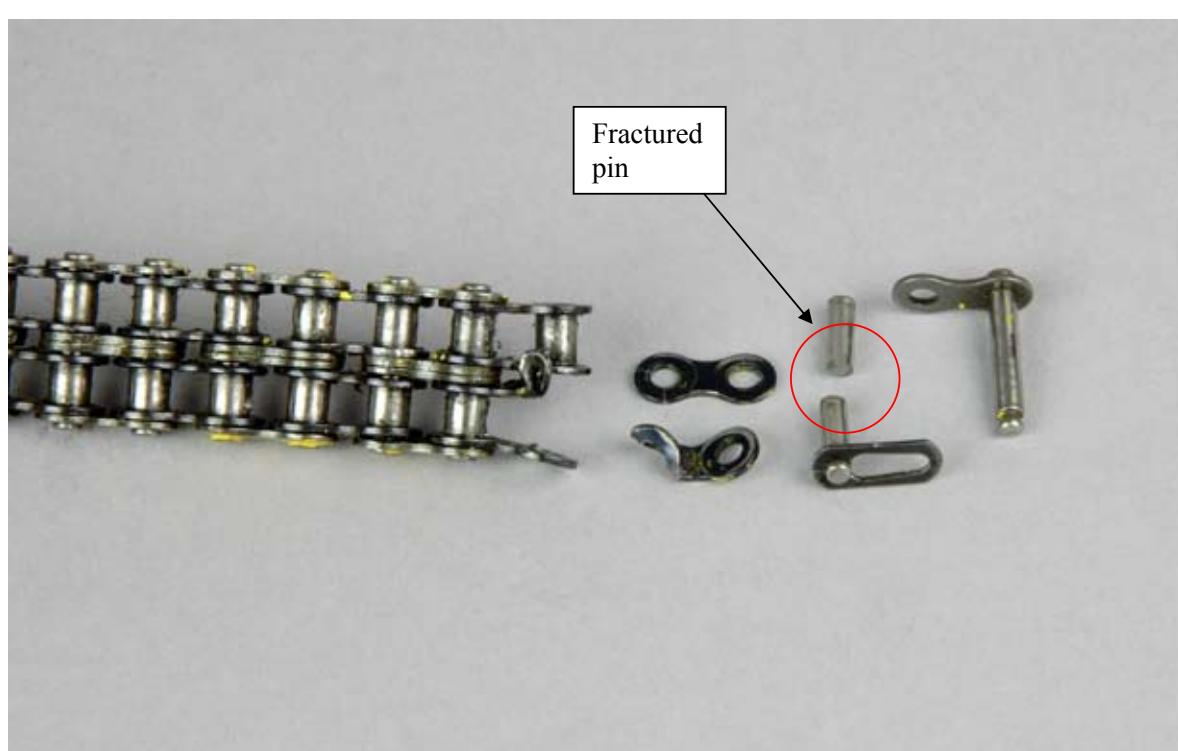


Figure 1
Failed chain link

The failed pin was sent for metallurgical analysis. Inspection of the pin, under a scanning electron microscope, showed evidence on the fracture surface that the failure was due to overload. No evidence of fatigue was identified. Several other cracks, which had not propagated to failure, were also identified when the pin was sectioned. The pin material composition and hardness were also tested and met the required specification.

Manufacturer's information

The chain manufacturer's website provides advice in the form of 'frequently asked questions' and contains the following:

'11. Roller Chain failure - Broken, Bent, or Turned Pins

Chain failed in service. Inspection of failure revealed a bent or broken pin, or pins that appear to be turned within the outer (pin) link plates.

ANSWER: Shock loads that are greater than the components yield strength, approximately 55-60% of the chains tensile [sic], are the cause of this problem. Changing to High Strength series chain, increasing the chain size (i.e. #80 up to #100), or working to eliminate the shock load on the drive system are some of the ways the chain's performance may be improved.'

Maintenance requirements

The approved maintenance schedule for the aircraft requires four inspections of the chain to be carried out over a period of 800 flying hours or 2 years, with 200 flying hours between each inspection. The first inspection in the cycle checks for wear and condition, the remainder ensure the chain is free from obstruction

and correctly tensioned. The chain is an 'on condition' item and is only replaced when wear limits are exceeded, but the gearbox and motor undergo overhaul every 8000 cycles or 6 years. Checking for wear in the chain consists of measuring the length of a number of links whilst the chain is under a specified tensional load. Limits for the amount of increase in the length of the chain from new are prescribed in the AMM. This test was carried out on the chain during the investigation and it was found to be within manual limits.

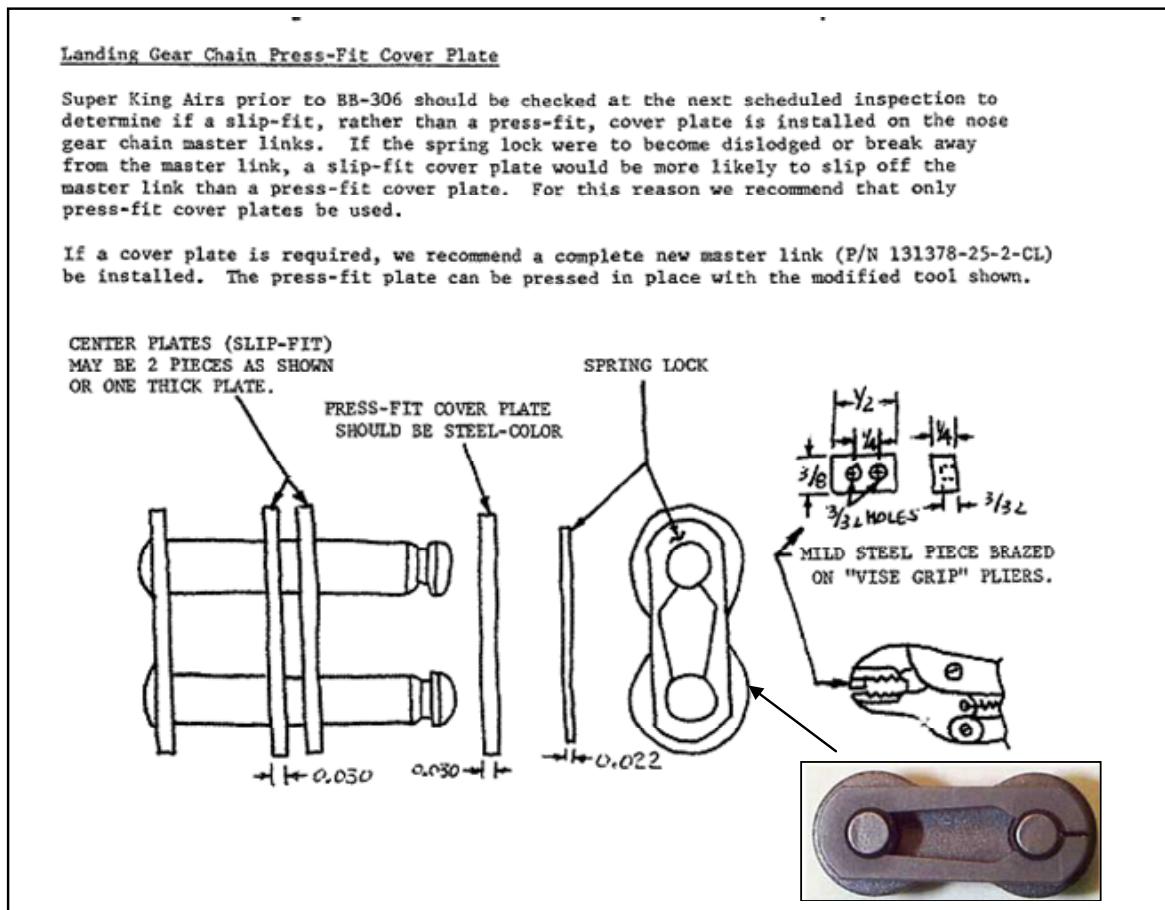
Service history

The landing gear was last overhauled on 15 November 2005, 935.5 hrs and 885 cycles previously. The operator's maintenance organisation stated that during this overhaul the chain had been refitted in accordance with the instructions contained in the AMM.

No further removals of the chain were carried out prior to the accident.

Maintenance documentation

Model Communiqué No 16, dated 13 January 1978 was issued by the aircraft manufacturer advising replacement of a 'slip-fit' plate on the master link, with a 'press-fit' plate to retain the master link in the event of the spring lock becoming detached. This communiqué was applicable to aircraft serial numbers prior to BB-306. The accident aircraft serial number was BB-568, suggesting that the chain master link should be the same as the arrangement shown in Figure 2. Examination of the recovered parts of the chain indicated that the pins may not have been pressed through the rear cover plate to the full extent; as such there was insufficient gap remaining for the front 'press-fit' cover plate to be fitted underneath the spring clip. A front cover plate was not recovered from the aircraft following the accident (Figures 1 and 2).

**Figure 2**

Master link modification

The operator's maintenance staff were unaware that a 'press-fit' cover plate should have been fitted in this position on the chain. They reported that as the AMM did not provide any detail regarding the assembly/disassembly of the master link during removal/installation of the gearbox and did not refer to Model Communiqué No 16, it is possible that a 'press-fit' cover plate may not have been fitted to the chain for some time.

Other events

The aircraft manufacturer advised that their records showed one similar nose gear failure event in March 2001 which was caused by a detached nose gear drive chain. This chain had the same part number as the chain from G-BGRE. The subsequent investigation attributed the

failure to incorrect reassembly of the chain following removal of the gearbox for overhaul.

The manufacturer also searched the FAA Accident/Incident Data System (AIDS) which listed the following event involving the nose gear chain:

'Data Source: Accident and Incident Database'

Report Number: 20070712012309C

NARRATIVE

On July 12, 2007 at approximately 1700 CDT, while on a local CFR Part 91 maintenance flight, a Beechcraft model BE-200, landed on Runway 17R at Lubbock International Airport

(klbb) with the nose gear in the retracted position. The aircraft sustained damage to both propellers, both nose gear doors and radome. There were no injuries to the pilot or the mechanic onboard. Examination of the aircraft revealed failure of the aft nose gear actuating chain located underneath the cabin floor, between the main gear actuator gearbox and the forward bulkhead. Failure of the chain rendered emergency gear extension ineffective.'

Information from the aircraft manufacturer indicated that the chain master spring link had detached and that the link had a 'slip-fit' type cover plate.

Analysis

Forensic analysis of the fractured pin showed that the failure of the chain occurred in a single overload event. Advice from the chain manufacturer suggests that this may have been due to shock-loading of the chain. Given the design of the landing gear system when the motor brake activates, it can result in shock loads being transferred through the gear chain. This type of load could have occurred during gear retraction after takeoff, which is consistent with the warning indications observed during the accident flight and the

subsequent failure of the nose gear to extend fully when selected. The damage identified to the chain plates is likely to have been caused by the sprocket teeth as the failed link travelled around the gearbox sprocket.

It was not possible to determine whether the lack of a 'press-fit' front cover plate may have contributed to the failure of the pin. However, fully inserting the pins into the rear cover plate and fitting a front 'press-fit' cover plate as defined in Model Communiqué No 16 would most likely have prevented the failed link becoming completely detached after the pin fractured. This may have allowed the gear system to continue to operate until the nose gear had fully extended. With a failure of the drive chain in this manner, the emergency extension system is rendered ineffective as it requires the nose gear drive chain to be serviceable to lower the nose gear leg.

Only two previous nose gear failure events, associated with a separation of the landing gear drive chain, could be identified in the extensive service history of the aircraft. Of these, one was caused by maintenance issues and the other failure mode was due to the detachment of the spring lock on a chain fitted with a 'slip-fit' cover plate. The aircraft manufacturer has introduced a hydraulic landing gear system on more recent versions of this aircraft type.