

INCIDENT

Aircraft Type and Registration:	Robinson R44 Raven II, G-CEFR	
No & Type of Engines:	1 Lycoming IO-540-AE1A5 piston engine	
Year of Manufacture:	2006	
Date & Time (UTC):	16 December 2006 at 1115 hrs	
Location:	On approach to Ballymena, Northern Ireland	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 3
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Distorted lower rib within mast fairing	
Commander's Licence:	Not known	
Commander's Age:	Not known	
Commander's Flying Experience:	Not known	
Information Source:	CAA occurrence report and further enquiries by the AAIB	

Synopsis

During an approach to land the almost-new aircraft started to oscillate in pitch with vibration felt through the cyclic control. The pilot was unable to reduce the oscillation or vibration using control inputs so he made an expedited run-on landing. The vibration was a result of new, softer, main rotor gearbox mounts allowing excessive fore and aft rocking of the gearbox. The manufacturer has replaced these mounts with stiffer types on new aircraft.

History of the flight

The pilot had just completed an uneventful 15 minute local sightseeing flight, with three children onboard, from a private site at Greenisland, near Belfast. Shortly afterwards the pilot departed on his second flight, with

three adults onboard, to ferry them to a rugby club approximately 20 miles away. On arrival at the site, the pilot positioned the aircraft for a right-hand circuit and into-wind approach. While on the downwind leg, in a shallow descent at a height of approximately 700 feet agl and an airspeed of 75 to 80 KIAS, the aircraft suddenly started to oscillate in pitch and the pilot felt high vibrating control forces through the cyclic control. The pilot was unable to arrest the oscillation or vibration using normal control inputs. The magnitude of the oscillations and vibration continued to increase to the point where the pilot was concerned about the helicopter's structural integrity. He decided to land immediately and employed a run-on landing procedure. The aircraft came to a rest without any apparent damage to the aircraft or injury

to people on board. During the engine shutdown the vibration was still present, although engine temperatures and pressures were in the normal range.

This aircraft had completed a total of 18.1 hours since new.

Weight and balance

The aircraft's weight at the time of the incident was estimated at 2,470 lb, which was 30 lb below the maximum takeoff weight. The aircraft's CG was estimated at 93.9 inches aft of datum. The forward CG limit at that weight was 93 inches and the aft limit was 98 inches.

Examination of the aircraft and rectification work

The maintenance organisation carried out a number of inspections of the aircraft as recommended by the manufacturer. The only damage found was a distorted aluminium lower rib within the mast fairing assembly. It was suspected that this damage was caused by excessive rocking of the main rotor gearbox, causing the rear hydraulic servo to impact the rib.

The main rotor hub 'teeter' friction was measured at 22 lbf, which was 3 lbf beyond the 19 lbf limit. It was adjusted down to 6.2 lbf. The main rotor blade coning hinge frictions were found unevenly set, with one set to 4.5 lbf and the other to 2 lbf (no limit specified). Both were adjusted to 2.2 lbf.

The two forward main rotor gearbox rubber isolation mounts (p/n A653-1) were replaced with newer stiffer mounts (p/n A653-2), following the manufacturer's advice. The aircraft was subsequently flight tested at various weight and CG configurations, including maximum weight and maximum forward CG, with no recurrence of the vibration or oscillation problem.

Previous incident on this aircraft

The aircraft had suffered a previous incident of heavy vibration in November 2006 when the aircraft had logged 10.1 hours since new. During this incident the aircraft had been loaded to 2,566 lb (66 lb above maximum takeoff weight) with a CG of 93.64 inches (near the forward limit of 93 inches). Following this flight the maintenance organisation had carried out an inspection and flight test (at 2,350 lb) which did not reveal the same vibration problem. The maintenance organisation recommended that the aircraft should not be flown above the maximum takeoff weight and to avoid a CG near the forward limit, until the manufacturer had been consulted about the problem.

Manufacturer's assessment of the cause

The manufacturer stated that they first experienced this vibration problem during flight test in 1993. It manifested itself at forward CG when the CG was located forward of the main rotor gearbox. The vibration was caused by the gearbox rocking fore and aft on its mounts, which was then felt as a 0.6 per 'main rotor revolution' vertical vibration (the natural frequency of the rotor system). The pilot was able to cure the problem by increasing power.

To eliminate the excessive vibration the manufacturer replaced the forward gearbox mounts (originally p/n C653-4) with stiffer mounts (p/n A653-1). Following the incident to G-CEFR the manufacturer measured the stiffness of new A653-1 mounts and found that they were softer than A653-1 mounts manufactured in the year 2000. The manufacturer believes that this softening of the mounts resulted in a recurrence of the vibration problem. They have not found evidence that hub teeter friction or coning hinge friction contributes to the problem.

The manufacturer has therefore started installing new, stiffer, mounts (p/n A653-2) on their new aircraft and these were retrofitted to G-CEFR. The manufacturer has also found that as the mounts age in service, the rubber becomes harder. The mounts take a compression set from the heat and loads experienced during flight, and this makes them stiffer. This explains why the problem has mainly affected relatively new aircraft. Since June 2007 the manufacturer has been conditioning the mounts by heating them in a 200°F (93°C) environment under a 1,000 lbf load for 12 to 24 hours, thereby giving the mounts the compression set they would eventually take in service.

On 28 August 2007, the manufacturer reported to the AAIB that they were no longer encountering the vibration problem during production flight test and that they had not received any further reports of vibration incidents from in-service aircraft. Therefore, the manufacturer does not plan to issue a service letter about the problem, although this situation would be reconsidered if new reports of vibration were received.