Robinson R22 Beta, G-BOAM

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Aircraft Type and Registration:	Robinson R22 Beta, G-BOAM
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Year of Manufacture:	1987
Date & Time (UTC):	26 May 1998 at 0925 hrs
Location:	Redhill Airfield
Type of Flight:	Training
Persons on Board:	Crew - 2 - Passengers - Nil
Injuries:	Crew - Nil - Passengers - N/A
Nature of Damage:	Sprag clutch assembly damaged
Commander's Licence:	Airline Transport Pilot's Licence (Helicopters)
Commander's Age:	37 years
Commander's Flying Experience:	3,043 hours (of which 1,940 were on type)
	Last 90 days - 73 hours
	Last 28 days - 33 hours
Information Source:	AAIB Field Investigation

History of the flight

The student was about to carry out a simulated 'engine-off' auto-rotation landing on the airfield from a height of 1,000 feet agl. However, as the instructor was closing the throttle into the detent to initiate the descent, he heard a loud 'bang' from the rear of the helicopter which was accompanied by rapid right/left yaw. The instructor therefore took control, closed the throttle fully and carried out an engine-off landing. He then left the engine at idle, handed control back to the student, disembarked and carried out an external inspection of the helicopter. However he could not find any apparent problem and so instructed the student to shutdown the helicopter while he requested engineering assistance.

Engineering examination

An engineering inspection of the helicopter, including the drive train, showed no apparent fault. It was thought that a bird strike may have occurred and the instructor searched the approach path for related evidence. One large feather was found, but there were no other indications of a bird strike. A ground run was then carried out, again with no fault found. The helicopter was cleared for a circuit and return to dispersal; this was performed and an auto-rotation landing was carried out without any further indication of a problem. A second engineering inspection was carried out at the

dispersal during which the freewheeling sprag clutch assembly, part number A018-2, was rotated several times in the 'over-run' direction. During one rotation of the clutch pulley, the clutch was felt to 'hang-up' and the main driveshaft turned for approximately 45° of one turn before releasing with an audible 'click'. However, it was not found possible to repeat this effect, despite several attempts. The clutch assembly was therefore removed for investigation.

The sprag clutch (part number A188-2, serial number 3926) had been replaced by the helicopter manufacturer during previous overhaul of the sprag clutch assembly and had accumulated 320 hrs on this helicopter, which was operated by a Flight Training School, since the overhaul. A similar sprag clutch, part number C188-3, is fitted to the Robinson R44 helicopter.

Examination of the sprag clutch assembly (Figure 1)

When the sprag clutch assembly was dismantled by one of the manufacturer's approved engineering organisations, it was found that one of the sprags was no longer retained within the sprag cage due to the failure of both ends of that sprag. One of the failed ends of this sprag was found loose within the sprag assembly; the other failed end was not found (Photograph 1). Another sprag, which had been retained within the sprag cage, had one end missing (Photograph 2). This sprag end was also not recovered. Following this initial engineering examination, the AAIB was informed of the incident.

Detailed visual and macroscopic examination of the sprag clutch assembly by the AAIB revealed the following:

The failures of the ends of the loose sprag and the retained sprag had occurred as a result of a medium cycle tension fatigue mechanism. The fracture in the retained sprag was associated with a spalled region, although fatigue cracking had not initiated in this region. All the sprags had been damaged to varying degrees by localised heavy frettage/wear, and one other sprag was cracked. The load transmission faces of many of the sprags had been damaged by spalling. The damage found indicated that tilting of the sprags relative to the rotational axis of the clutch had occurred in service.

Examination of the outer surfaces of the clutch housing, the inner surfaces of the end plates, part number A168, and the mating faces of these parts on the pulley showed the presence of patches of localised heavy damage arising from frettage. Such frettage occurs due to large tangential movements between mating surfaces.

Examination of the driveshaft outer diameter surface showed evidence of eccentric running within the sprag clutch assembly.

Examination of the sprag clutch assembly from R22, G-BUIW

Following correspondence with the helicopter manufacturer, the sprag clutch serial number 3923 from another Robinson R22, G-BUIW, which had been involved in a fatal accident near Thruxton airfield on 9 March 1998 (AAIB Bulletin 11/98), was subjected to a detailed metallurgical examination. Upon dismantling this sprag clutch assembly it was found that a sprag ear had failed. The conclusions from the metallurgical examination were that the damage exhibited by the parts of this sprag clutch and its housing were almost identical to that found in the sprag clutch from G-BOAM. The fracture of the sprag ear had resulted from a high cycle fatigue mechanism caused by simple inward bending. There was good evidence to indicate that the ear which had broken away

from the sprag had migrated into the bearing raceway and it was considered that it could possibly have locked, for a short period of time, the rotational movement of the bearing races relative to one another. There was evidence of eccentric running of a bearing outer raceway within the sprag clutch housing.

Action taken by the helicopter manufacturer

Following the incident to Robinson R22, G-BOAM, the helicopter manufacturer found additional sprag clutches that contained broken sprag ears from both R22 and R44 helicopters. After some detailed examinations and discussions with the sprag clutch manufacturer, the problem was identified to have stemmed from a sprag manufacturing process change introduced by the sprag clutch manufacturer which affected specific batches of R22 and R44 sprag clutches. The sprag clutch assemblies from G-BOAM and G-BUIW were from the affected batches. On 22 March 1999 the helicopter manufacturer issued Service Bulletin SB-85 for the R22 and Service Bulletin SB-32 for the R44 which required the replacement of all the affected sprag clutch assemblies within 150 flight hours or by 31 July 1999, whichever occurred sooner.