Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A05O0115

MAIN ROTOR BLADE FAILURE

TASMAN HELICOPTERS LTD.
BELL 212 (HELICOPTER) C-GNHX
RICHARDS LANDING, ONTARIO
10 JUNE 2005

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

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Summary

The Bell Textron 212 helicopter (registration C-GNHX, serial number 30983) was being ferried from Bolton, Ontario, to Richmond, British Columbia. The recently purchased helicopter was being flown by the company's chief pilot with two passengers on board. At 1220 eastern daylight time, the helicopter was at an altitude of 1500 feet above sea level with an airspeed of 100 knots, when there was a series of loud bangs immediately followed by severe airframe vibrations. The pilot had difficulty controlling the helicopter for the next 10 to 15 seconds.

The pilot immediately lowered the collective, pulled back on the cyclic control and brought the engine throttles to idle. He regained control of the helicopter, but the banging and vibrations continued. Every time one of the advancing main rotor blades came forward, it would climb off track abnormally. The vibrations and banging became more severe as the flight continued. The pilot proceeded toward a large ploughed field for an emergency landing. As the airspeed decreased, the helicopter became more controllable, and a successful landing was carried out. There were no injuries to the occupants. The helicopter was substantially damaged from the in-flight vibrations.

Ce rapport est également disponible en français.

Other Factual Information

The weather for the flight was good visual meteorological conditions and was not considered to be a factor in this occurrence.

Records indicate that the aircraft was maintained in accordance with existing regulations and approved procedures. The pilot was certified and qualified for the flight.

After landing, a post-flight inspection revealed that one of the main rotor blades had sustained damage. A small section of skin near the blade tip, aft of the spar doubler, on the lower surface of the rotor blade had debonded. The skin was raised and curled, but had not separated from the blade (see Photo 1). The debonded skin measured 25 inches by 2 inches between stations 263 and 288. It was later discovered that several of the main rotor head components and transmission had been damaged by the severe vibrations encountered during the flight.

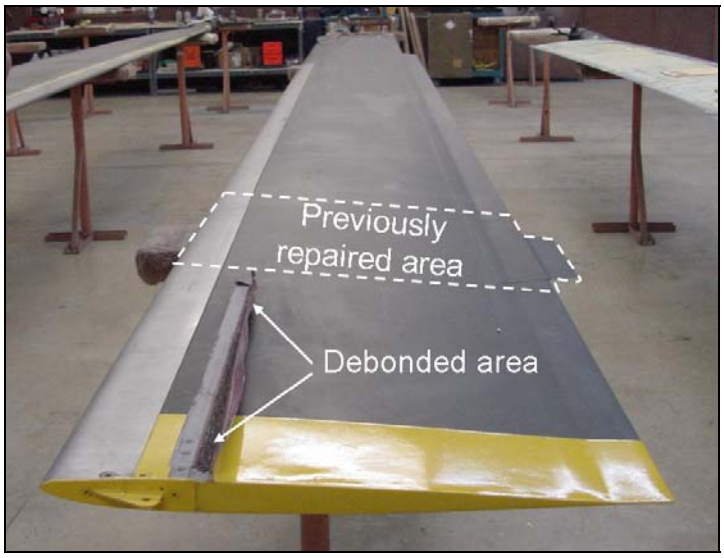

Photo 1. Debonded lower surface of rotor blade and repair area (blade resting upside down)

The damaged main rotor blade (part number 212-015-501-115, serial number A-3257) had accumulated 3251 hours of flight time since new. The total service life for the blade was 4000 hours. A review of the blade's service records indicated that it was manufactured by Bell Helicopter and entered service in December 1996.

In early 2005, the same blade had been damaged while the helicopter was parked in a hangar. The blade was then shipped to an authorized rotor blade repair shop.

While paint was being stripped from the rotor blade in preparation for repair, deep corrosion pitting was discovered on the lower skin surface between stations 243 and 262, just inboard of where the debonding later occurred on the 10 June 2005 flight (see Photo 1). Because the pitting pattern exceeded the allowable limits, the repair shop proposed a repair procedure to Bell Helicopter and received approval. The repair procedure included removing the damaged skin and replacing it with a bonded external doubler. The trailing edge trim tab was also replaced.

The skin–to–inner core bonding procedure required using a bladder and heater blanket tool. This tool ensures proper curing of the adhesive by applying heat and pressure to the area being repaired. This type of repair is performed regularly to repair damaged rotor blades. The bladder and heater blanket tool that was used covered the rotor blade from its tip to a point inboard of the repair area, which included the area where the debonding took place on the occurrence flight. The repair process called for the temperature to be controlled and monitored during the

entire cure cycle. After the repair was completed, the blade was inspected by tap hammer in the repair area and all the way to the tip. The blade was then returned and installed on C-GNHX. As part of the investigation, records of the repair procedure were reviewed by the TSB Engineering Laboratory and Bell Helicopter, and it was verified that the procedure was performed in accordance with the standard recommended procedures.

Following the repair using the bladder and heater blanket tool, the blade was in service for approximately four flight hours before the lower skin debonded on the occurrence flight at the spar doubler between stations 263 and 288.

The debonded section between stations 263 and 288 was examined. There was a cohesive bond of the adhesive to the skin substrate. However, the original bonding adhesive used during the manufacturing process was not uniformly adhered to the spar doubler; only small remnants of the adhesive remained (see Photo 2). The total amount of adhesion could not be accurately quantified because the adhesive on the skin and on the spar doubler had eroded. This erosion of the adhesive was caused by the airflow and environmental elements entering the debond area in the time frame between the skin debonding and the completion of the emergency landing.

Photo 2. Close-up of blade tip with arrows showing adhesive residue on the spar doubler

A scanning electron microscope examination of the debonded skin sample indicated that the adhesive, while remaining firmly attached to the skin, had replicated sanding marks from the spar along the adhesive to spar interface, clearly showing that most of the adhesive had bonded well to the skin, but not to the spar. There was little indication of any adhesive remaining attached to the spar surface. The sanding marks on the spar surface are indicative of the standard procedure used for surface preparation before applying the adhesive. Following this initial examination, preparation for repairing the blade was begun by cleaning the spar surface. However, during this process, the surface was altered, and bonding evidence was removed, preventing further analysis of the bond to the spar surface.

Other sections of the blade were examined to determine the overall adhesive nature of the bond between the skin and spar surface. Further samples of skin were peeled from different sections of the blade inboard of the area damaged on the occurrence flight. The area where the previous repair had been completed showed sporadic cohesive separation on the skin side. All of the other samples removed indicated even adhesion between the skin and spar surfaces.

During the examination of other sections of the blade along the spar doubler, two areas were discovered where the honeycomb inner core was crushed and had separated from the rear of the spar. The two areas were located between station 211 and station 224 and between station 263 and station 287. A layer of foam adhesive rests between the core and the spar (see Photo 3). In the two damaged areas, the adhesive foam was present at the spar, but there was no contact between the adhesive foam and the core. Bell Helicopter's Engineering Department determined that, even though there was a non-effective bond between sections of the honeycomb core and the spar, the skin–to–spar bondline would not have experienced static or fatigue failure during the service life of the rotor blade.

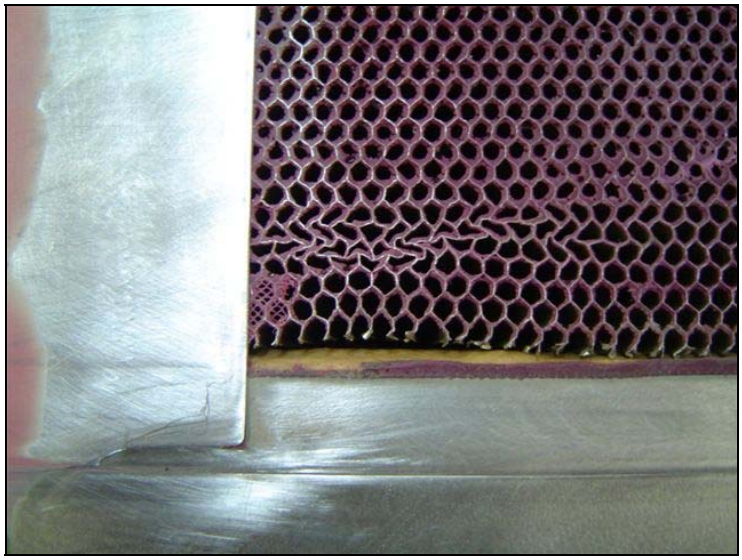

Photo 3. Honeycomb core crush and separation for spar

The available records were examined to determine if this blade had incurred any additional damage during its service life. There was no indication of any additional damage.

Analysis

While the rotor blade service life was 4000 hours, this rotor blade had accumulated only 3251 flight hours before the debonding during the occurrence flight. A primary focus of this investigation was to assess whether the repair process that had been completed only four flight hours before the debonding failure was connected to what happened on the occurrence flight.

Before both this occurrence and the previous event earlier in the year, there had been no reported problems with the blade. All repair work carried out in the previously damaged area had been approved by Bell Helicopter and was performed in accordance with standard procedures. Records of the repair did not indicate any deviations that might have contributed to the blade skin debonding on the occurrence flight.

During the examination of the bond between the spar doubler and the skin, in different areas of the affected blade, it was determined that all areas inboard of the repaired section exhibited cohesive bonding. However, the previously repaired area showed sporadic cohesive separation on the skin side, and the debonded area showed that the bond between the spar doubler and the skin was not cohesive.

The possibility that the weak bond in the failure area was the result of a deficiency during the manufacturing process was assessed. This possibility was discounted, as it is considered unlikely that the blade could have accumulated 3251 flight hours with this defect in place with no reported problems.

While the damaged rotor blade had been previously repaired using a procedure that is performed on a regular basis in the industry, the possibility was considered that integrity of the blade, in the debonding area, was affected during this previous repair process. Since the two areas are adjacent to one another and are the only areas where improper bonding was identified, the possibility was considered that the bladder and heater blanket used in the curing process during the previous repair could have played a role in this occurrence. With the bladder and heater blanket covering an area extending from the blade tip to a point inboard of station 243, the section of the blade that eventually failed was undergoing the same temperature and pressure cycle as the section being repaired. However, there was nothing found that would indicate that the heat and pressure cycle had any adverse effect on the section of blade that delaminated.

Although damage during the previous repair could have been the starting point for the debonding during the occurrence flight, it is not possible to conclude this with certainty. If the repair process was involved, it would have been the result of a weakening of the bond through an influence on the adhesive.

Bell Helicopter's Engineering Department determined that the debonding between the honeycomb core and spar would not have resulted in the skin separation. There were two areas on the blade observed to have core/spar separation. The first was located between station 263 and station 287, in the area where the lower skin debonded. The second area was located between station 211 and 224. This second area of damage was located away from the repaired area and the debonded area, indicating that this type of damage most probably occurred during the original manufacturing process.

The following Engineering Laboratory report was completed:

LP 066/2005 – Main Rotor Blade Adhesive Failure

This report is available from the Transportation Safety Board of Canada upon request.

Finding as to Causes and Contributing Factors

1. A section of the main rotor lower blade skin debonded during flight, causing the helicopter to develop severe vibrations resulting in an emergency landing.

Finding as to Risk

1. The second area of blade damage likely occurred during the manufacturing process, but was not detected at that time. No information is available to assess how this type of damage affects blade integrity and the associated consequences during operations.

Other Finding

1. Although the debonding took place within the area where the bladder and heater blanket was used, the investigation could not confirm whether the heat and pressure cycle had any adverse effect on the section of blade that delaminated.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 01 November 2006.

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