AVIATION INVESTIGATION REPORT

A00P0208

MAIN-ROTOR BLADE FAILURE

PRISM HELICOPTERS LTD

MD HELICOPTER 369D, C-GXON

MT. MODESTE, BRITISH COLUMBIA 5 NM NW

31 OCTOBER 2000

Aviation Investigation Report

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Prism Helicopters Ltd
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Report Number A00P0208

Summary

The MD helicopter 369D, serial number 370093D, was returning to Lake Cowichan, British Columbia, at about 1725 local time. The pilot had spent the day transporting cedar shake blocks in the Jordan River area. At about 1800 the helicopter was reported missing, and a search was begun at about 1845. An emergency locator transmitter signal was detected in the Mt. Modeste area. During the night, a ground search party found the destroyed helicopter, minus its tail. The pilot, who was the sole occupant, was in the wreckage and had been fatally injured. No fire had occurred.

Ce rapport est également disponible en français.

Other Factual Information

On the day of the accident, the pilot flew the helicopter to the Jordan River area to spend the day transporting cedar shake blocks. The weather was mostly clear, allowing for visual flight rules (VFR) flight, and the winds were light and variable. Sunset was at 1655 Pacific standard time (PST),[1] and it turned dark at 1728. That day the pilot flew 4.9 hours, making 123 lifts, and transported the ground crews three times. At about 1715 he departed Jordan River for the 23-minute flight back to Lake Cowichan. He had filed a flight plan in the morning for the day's flying. The flight plan was to be closed by 1745, but since it was not, a search was initiated one hour later.

The emergency locator transmitter activated when the helicopter collided with terrain. The crew of a Canadian Armed Forces search-and-rescue aircraft found the area of the downed helicopter and helped a ground search team find the main wreckage. The tail section had broken away from the helicopter and was found two days later, about one kilometre behind the main wreckage. The terrain of the accident site is mountainous, with second-growth trees and large areas that had been logged in the past 20 years.

The helicopter struck the ground in a left-bank, nose-down attitude. Pieces of the helicopter and its contents were scattered around the main wreckage, up to 500 feet away. The fuselage was severely crushed by the high impact forces and was skewered by two small trees. Only one other tree in the area was damaged by the falling helicopter. The fuel cell had burst on impact, and there was a strong smell of fuel, but no fire had occurred.

Marks on the aft fuselage showed that the main rotor blades had severed the tail section. All of the lead and lag blade dampers were torn apart. The helicopter is fitted with five main-rotor blades that are identified by colour. The red blade was notable in that it showed a clean break about one-third of the distance from its root (see Figure 1). The break was perpendicular to the leading edge of the blade, and the break in the spar was recessed from the skin. The outboard two-thirds of this blade was not found. The white blade was missing completely, including its main-rotor blade grip. The yellow blade was missing its end one-third and showed clear damage from hitting the tail section. The green blade was torn into two pieces after it had stopped turning. The blue blade was the only blade in one piece. Apart from the damage caused by the blades striking the aft section of the fuselage in flight, the damage to the main-rotor system and the blades was consistent with that exhibited when the rotor is not turning or being driven at ground impact.

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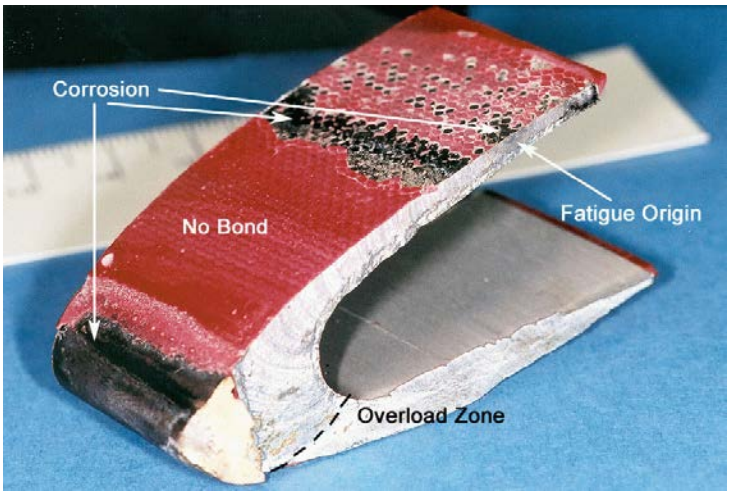
[1] All times are PST (Coordinated Universal Time minus eight hours).

The red blade, with the clean break, was removed from the wreckage and transported to an independent engineering facility for examination. Detailed visual and scanning-electron microscope inspections revealed a bonding void between the blade skin and the spar. It also revealed corrosion pits in the spar, in the area of the bonding void. A fatigue crack had propagated from one of the pits and through the spar until the weakened blade failed from overload. The corrosion pit revealed chlorine and sulphur, as happens when the corrosion is from a marine or industrial environment.



The manufacturer of the main-rotor blades was an approved parts manufacturer for main-rotor blades for the 369D. Early manufacturing of these blades included a process of checking for voids in bonding by monitoring for an uninterrupted squeeze-out of bonding material. In 1999 this check was supplemented by a "tap inspection". Tap inspections are done by tapping the surface of the blade with a metal object, often a coin, and listening for a change in tone to identify voids. (Criteria have been established for acceptable voids.) The main-rotor blade with the clean break was manufactured before 1999.

The pilot was the chief pilot of Prism Helicopters Ltd. He held a private aeroplane licence and a commercial helicopter licence. He was appropriately certificated and had a flight medical examination on 2 August 2000. This examination, like previous ones, showed that he was in good health. He had about 5800 hours of flying time, most of which was in the 369D.

The helicopter was maintained in accordance with the manufacturer's, Transport Canada's, and the company's criteria. There were no outstanding deficiencies recorded. Four of the main-rotor blades, including the blade that failed, had accumulated about 2658 hours of flight time each. One blade had about 673 hours. The life limit of the main-rotor blades was 3530 hours.

The helicopter manufacturer reported that the tail section could break under extreme vibrations, as would occur if a rotor blade or blade section was lost in flight.

Analysis

From the available information, it was concluded that the red blade, with the clean break, failed in flight and was the initiating event in this accident. When the section of the blade was lost, a large imbalance was created in the rotor system leading to the failure of the lead and lag dampers. The imbalance would also cause extreme

vibrations. The pilot would have difficulty holding onto the cyclic control stick but would be able to lower the collective control stick. There are two scenarios, either of which, or both, could result in the main-rotor blades severing the tail section. The first scenario is that extreme vibrations compromised the tail-boom strength, causing the tail section to break and flex into the path of the main rotor. The second scenario is that the loss of a large portion of a main-rotor blade created such an imbalance that the blades flew in an erratic and extreme path and struck the tail boom.

In-flight loss of the tail section would cause the pilot to lose attitude control, and the helicopter would spin around its mast. In an attempt to stop the helicopter from spinning, the pilot would likely carry out the emergency procedure for loss of yaw control due to a lack of tail-rotor thrust: that is, lower the collective and close the throttle. However, even after the pilot had closed the throttle to remove engine torque, the spinning would not stop quickly because there would be no tail surface to resist the yaw. The spinning was evident by the circular distribution of helicopter pieces and contents. These objects struck the terrain vertically, indicating that they had separated from the helicopter at a relatively high altitude. The helicopter's autorotation characteristics would have been destroyed by the loss and damage of the main-rotor blades, causing the rotors to stop before impact. The loss of the tail section would move the centre of gravity far enough forward to cause the helicopter to pitch nose-down uncontrollably.

The crack in the spar of the failed rotor blade did not manifest itself through the outer skin because of the lack of bonding between the main-rotor blade spar and the outer skin. Therefore, the crack would not have been identifiable by visual inspection before the blade failure.

Tap inspections were not done on the blades manufactured before 1999. Because voids were found on these early blades, it was possible that there were more blades in the system that were susceptible to the same corrosion, fatigue cracking, and failure.

Findings as to Causes and Contributing Factors

1. Two thirds of one of the helicopter's five main-rotor blades separated in flight, and one or two of the remaining main-rotor blades struck and severed the tail section in flight, all of which made the helicopter uncontrollable.

2. There was no bonding on part of the skin on the main-rotor blade that separated, which allowed corrosion pits to form in the blade. A crack propagated from one of the pits, and the blade failed in fatigue. The crack in the main-rotor blade was not visually identifiable before the flight.

Findings as to Risk

1. It is possible that main-rotor blades manufactured by the approved parts manufacturer before 1999, that were not tap inspected, have voids in their bonding and are susceptible to the same corrosion, fatigue cracking, and failure.

Safety Action Taken

After confirming that there was a manufacturing flaw—the lack of bonding in the area of blade separation—in the main-rotor blade, the manufacturer of the blades took immediate action. The manufacturer informed operators of the problem and issued a Mandatory Service Bulletin on 6 November 2000 to check the bonding on affected 369D blades before the next flight. The US Federal Aviation Administration issued an Airworthiness Directive on 20 November 2000 requiring compliance with the aforementioned Mandatory Service Bulletin. The Airworthiness Directive calls for a one-time inspection, before the next flight, of all of the 369D main-rotor blades manufactured by the approved parts manufacturer and establishes new criteria for acceptable voids in all new blades.

Several of the affected main-rotor blades exhibited voids, identified by the tap inspection, and were removed from service.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 24 May 2001.

Appendix A - Mandatory Service Bulletin

Helicopter Technology Company, LLC

NOTICE No.:2100-2

Mandatory Service Bulletin

DATE: 6 November 2000

INSPECTION OF MAIN ROTOR BLADE

SUMMARY: **HTC has discovered a Main Rotor Blade with an adhesive void outside the allowable manufacturing tolerance.**

PURPOSE: The purpose of this bulletin is to perform a one-time coin tap inspection before next flight. Perform the test per the instructions below. Should the voids exceed those identified as allowable please notify Helicopter Technology Co. for disposition.

PART NUMBERS AFFECTED: 500P2100-BSC (STC No: SR09172RC) Serial numbers K101 through K394. 500P2100-101 and -301(STC No: SR09074RC and SRO9184RC), Serial numbers A001 through A855.

HELICOPTER MODELS AFFECTED: MD Helicopters, Inc. Models 369A, H, HE, HM, HS, D, E.

SERIAL NUMBERS AFFECTED: A001 through A855 inclusive, and K101 thru K394 inclusive.

TIME OF COMPLIANCE: Accomplish prior to the next flight.

ONE TIME INSPECTION

Physically perform a coin tap inspection on both the upper and lower surfaces of the main rotor blade. Inspect the skin to spar bond from the outboard edge of the root fitting to the blade tip in the spanwise direction and from the leading edge to the aft edge of the spar in the chordwise direction. The allowable void size is 0.5 square inches. There shall be 1.0 inches between voids except for the aft .50 inches of the spar where there shall be a minimum of 2.0 inches between voids. The upper and lower surfaces shall be considered separately.

RECORDING AND COMPLIANCE:

Record compliance of this Service Bulletin in the Technical Directives and Bulletins section of the rotor blade Serviceable Component Record.

POINTS OF CONTACT:

For further information and rotor blade disposition, contact HTC at (310) 523-2750, or FAX (310) 523-2745.

The inspection requirement of this bulletin has been shown to comply with Federal Aviation Regulations and is FAA Approved.