



Aviation Investigation Final Report

Location:	Parlier, California	Accident Number:	WPR10LA138
Date & Time:	February 17, 2010, 14:50 Local	Registration:	N313DA
Aircraft:	ROBINSON HELICOPTER R22 BETA	Aircraft Damage:	Substantial
Defining Event:	Loss of control in flight	Injuries:	2 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The helicopter pilot was on the first leg of a ferry flight. The helicopter was 3.2 hours out of its 2,200-hour overhaul. The pilot reported that he was in straight-and-level flight and he initiated a right turn. The helicopter immediately rolled to the right and entered a low-G condition. The pilot responded appropriately and righted the helicopter. He then conducted a power-on landing. As the main rotor system came to a stop, one of the blades impacted the tailboom. Post landing examination of the rotorhead revealed that the pitch change link on the red main rotor blade had fractured, the spindle tusk had sheared off, and damage to both elastomeric teeter stops was evident. Metallurgical examination of the spindle tusk determined that it failed in a downward direction relative to the rotor blade due to shear overstress. Examination of the pitch change link determined that it failed due to overstress characterized by reverse bending numerous times to failure. Witness marks on the pitch link and pitch change arm indicated that the angle of the blade at the time of the pitch link failure was 45-degrees downward, an angle that could be achieved if the spindle tusk had already been fractured. According to Robinson Helicopter Company, this angle could also be obtained during extreme teeter of the hub/blade during a mast bumping event. A Robinson Helicopter Company publication notes, "Pushing the cyclic forward following a pull-up or rapid climb, or even from level flight, produces a low-G (weightless) flight condition. If the helicopter is still pitching forward when the pilot applies aft cyclic to reload the rotor, the rotor disk may tilt aft relative to the fuselage before it is reloaded. The main rotor torgue reaction will then combine with tail rotor thrust to produce a powerful right rolling moment to the fuselage. With no lift from the rotor, there is no lateral control to stop the rapid right roll and mast bumping can occur."

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot inadvertently entered a low-G condition during cruise flight, which resulted in a momentary loss of control of the helicopter and mast bumping.

Findings	
Aircraft	Prop/rotor parameters - Not attained/maintained
Personnel issues	Aircraft control - Pilot

Factual Information

Flistory of Flight	
Enroute-cruise Loss of	control in flight (Defining event)
Landing Off-field	or emergency landing

HISTORY OF FLIGHT

On February 17, 2010, at 1450 Pacific standard time, N313DA, a Robinson R22 Beta, forcelanded in a field near Parlier, California. The commercial pilot and one passenger were not injured. The helicopter sustained substantial damage to the main rotor assembly. The pilot operated the helicopter under the provisions of Title 14 Code of Federal Regulations Part 91 and visual meteorological conditions prevailed. The flight departed from Fresno Yosemite International Airport, Fresno, California, at 1430, and was on the first leg of a trip to North Las Vegas Airport, Las Vegas, Nevada. The first planned stop was Meadows Field Airport, Bakersfield, California.

According to the pilot, he was established in straight-and-level flight when he initiated a 10- to 20-degree banked turn to the right. The helicopter immediately rolled inverted and the pilot applied aft cyclic and lowered the collective. The pilot was able to regain control of the helicopter and perform a powered landing to a field. Damage to the helicopter included a fractured rotor blade spindle tusk, fractured pitch link, crushed elastomeric teeter stops, and a shallow, diagonal crease in the tail boom just forward of the tail rotor.

Pilot Statement

The pilot had just entered into a lease/purchase agreement on the helicopter. The pilot reported that he and a passenger were ferrying the helicopter from Fresno to Las Vegas and their initial stop was going to be Bakersfield. As he was approaching Reedley, California, at 1,100 feet mean sea level (800 feet above ground level (AGL)) and 85 knots, he initiated a "shallow right turn while slightly increasing collective." The helicopter "abruptly rolled to the right at a rate well in excess of 100 degrees per second. By the time I recognized a possible low G situation, we were inverted." The pilot immediately applied aft cyclic to reload the rotor disc and lowered the collective, which resulted in a split-S maneuver. He then entered a precautionary autorotation. At approximately 100 feet AGL and 70 knots, he arrested the descent and continued the autorotation to a field. As he approached the landing spot, he initiated a power recovery and entered a flare. He stated that he executed a normal set down, rolled off the power, and disengaged the clutch. As the main rotor slowed, it became evident to the pilot that the droop stops had broken and the blades began to sag. He applied the rotor brake and the retreating blade impacted the tail boom at a slow speed.

Passenger Statement

The passenger submitted a written statement. She reported that she was seated in the left seat of the helicopter and her boss was flying the helicopter. They were ferrying the helicopter from Fresno to Las Vegas. To her understanding, the helicopter was just purchased out of overhaul. When they got into the helicopter, the pilot did a preflight before they left the airport and began their flight to Las Vegas. The passenger was enjoying the flight and taking photographs when she noted to the pilot that the cyclic appeared shaky. The passenger's only other flight in a helicopter had been on an introductory flight, and she did not experience the cyclic vibrating during that flight. She indicated that because she is not a pilot, she did not know if the vibration was normal or not. She was looking out of the window when the helicopter tilted to the right, front side, and then became inverted. The passenger could see the ground coming up quickly. She screamed and then closed her eyes thinking that the helicopter was going to collide with the ground. In just a few seconds, the helicopter was upright and they were descending slowly to land. According to the passenger, the landing was a very smooth and gentle.

PERSONNEL INFORMATION

The pilot, age 35, held a commercial pilot certificate for airplane single and multi-engine (limited to center thrust) instrument land, and helicopters. He held a first-class medical certificate that was issued on October 20, 2009. It did not have any limitations or waivers. The pilot reported 1,702 hours of total flight time, with 1,580 in airplanes and 64 in helicopters. The pilot had 36 hours of pilot-in-command time in helicopters.

AIRCRAFT INFORMATION

The helicopter had undergone a 2,200-hour overhaul and had operated 3.2 hours at the time of the accident. Following the maintenance performed on the helicopter, it was flight tested. According to the test pilot that flight tested the helicopter, the helicopter performed normally. The test pilot had flown the helicopter prior to the overhaul and following the overhaul. According to the pilot, the helicopter performance and handling characteristics both before and after the overhaul were similar.

METEOROLOGICAL INFORMATION

A Safety Board meteorologist reviewed the meteorological conditions along the helicopter's route of flight. Light wind conditions were reported just above the surface and light chop was reported near the coast at higher altitudes. There were no indications of turbulent activity at the helicopter's altitude or along its route of flight. Additionally, no mountain wave activity was reported.

TESTS AND RESEARCH

A fractured pitch change link and the root of the red blade with the spindle were sent to the NTSB Materials Laboratory for examination. Optical examinations of the fracture region of the spindle tusk revealed fracture features and smearing indicative of a shearing overstress fracture. The indicated shearing direction was as if the inboard end of the tusk moved downward relative to the main rotor blade.

The pitch change link upper rod end fitting was fractured through the thread nearest to the head. Magnified optical examinations of the rod end fracture surfaces displayed fracture topography with opposed crescents and other features indicative of cyclic overstress where the rod was reverse bent a few times to failure. The orientation of the indicated axis of bending was measured to be about 81 degrees relative to the axis of the fitting head.

During examinations of the rod end fracture, mating damage patterns were noted on the fitting and on adjacent areas of the pitch change arm. The mating damage included a dent in the hat spacer that matched the edge of the monoball outer race, a dent in the vertical face of the pitch change arm and a corresponding paint chipping in the rod end paint and a angular dent in the lower face of the pitch change arm matching the edge configuration and deformation on one corner of the upper pal nut.

Matching the fracture surfaces and damage patterns of the pitch change link to the pitch change arm, positioned the link at nearly 45 degrees to the arm. According to the metallurgist, this angle would occur with the main rotor blade at a large droop angle that could be attained if the tusk on the spindle were fractured. A representative from Robinson Helicopter Company indicated that this angle could also occur during extreme teetering of the main rotor hub during a mast bumping event.

ADDITIONAL INFORMATION

According to section 4 of the pilot's operating handbook for the R22, "Mast bumping may occur with a teetering rotor system when excessive main rotor flapping results from low "G" (load factor below 1.0) or abrupt control input. A low "G" flight condition can result from an abrupt cyclic pushover in forward flight. High forward airspeed, turbulence, and excessive sideslip can accentuate the adverse effects of these control movements. The excessive flapping results in the main rotor hub assembly striking the main rotor mast with subsequent main rotor separation from the helicopter."

According to Robinson Helicopter Company Safety Notice SN-11, Low-G Pushovers Extremely Dangerous, "Pushing the cyclic forward following a pull-up or rapid climb, or even from level flight, produces a low-G (weightless) flight condition. If the helicopter is still pitching forward when the pilot applies aft cyclic to reload the rotor, the rotor disk may tilt aft relative to the fuselage before it is reloaded. The main rotor torque reaction will then combine with tail rotor thrust to produce a powerful right rolling moment to the fuselage. With no lift from the rotor, there is no lateral control to stop the rapid right roll and mast bumping can occur. Severe inflight mast bumping usually results in main rotor shaft separation and/or rotor blade contact with the fuselage."

According to RHC Safety Notice SN-29, Airplane Pilots High Risk When Flying Helicopters, "To stay alive in the helicopter, the experienced airplane pilot must devote considerable time and effort to developing safe helicopter reactions. The helicopter reactions must be strong and take precedence over the pilot's airplane reactions because everything happens faster in a helicopter...To develop safe helicopter reactions, the airplane pilot must practice each procedure over and over again with a competent instructor until his hands and feet will always make the right move without requiring conscious thought."

Pilot Information

Certificate:	Commercial	Age:	35,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 1 Without waivers/limitations	Last FAA Medical Exam:	October 20, 2009
Occupational Pilot:	No	Last Flight Review or Equivalent:	January 25, 2010
Flight Time:	1702 hours (Total, all aircraft), 64 hours (Total, this make and model), 1301 hours (Pilot In Command, all aircraft), 38 hours (Last 90 days, all aircraft), 18 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

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Aircraft Make:	ROBINSON HELICOPTER	Registration:	N313DA
Model/Series:	R22 BETA	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	3860
Landing Gear Type:	Skid	Seats:	2
Date/Type of Last Inspection:	February 1, 2010 Annual	Certified Max Gross Wt.:	1370 lbs
Time Since Last Inspection:	3 Hrs	Engines:	1 Reciprocating
Airframe Total Time:	3 Hrs as of last inspection	Engine Manufacturer:	LYCOMING
ELT:	C91 installed, not activated	Engine Model/Series:	O-360 SERIES
Registered Owner:	HELIMARK LLC	Rated Power:	180 Horsepower
Operator:	Richard Coe	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	FAT,336 ft msl	Distance from Accident Site:	15 Nautical Miles
Observation Time:	14:53 Local	Direction from Accident Site:	300°
Lowest Cloud Condition:	Few	Visibility	5 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	/	Turbulence Type Forecast/Actual:	/
Wind Direction:		Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.95 inches Hg	Temperature/Dew Point:	21°C / 11°C
Precipitation and Obscuration:	N/A - None - Haze		
Departure Point:	Fresno, CA (FAT)	Type of Flight Plan Filed:	None
Destination:	Bakersfield, CA (BFL)	Type of Clearance:	None
Departure Time:	14:30 Local	Type of Airspace:	

Wreckage and Impact Information

Crew Injuries:	1 None	Aircraft Damage:	Substantial
Passenger Injuries:	1 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	2 None	Latitude, Longitude:	37.623611,-119.506942(est)

Administrative Information

Investigator In Charge (IIC):	Dunks, Kristi
Additional Participating Persons:	Bjorn Beijens; Federal Aviation Administration; Fresno, CA Thomas Webster; Robinson Helicopter Company; Torrance, CA
Original Publish Date:	July 22, 2010
Last Revision Date:	
Investigation Class:	<u>Class</u>
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=75375

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available <u>here</u>.