Aviation Investigation Final Report

Location:	Colusa, California	**Accident Number:**	WPR21FA300
Date & Time:	August 1, 2021, 12:51 Local	**Registration:**	N7000J
Aircraft:	ROBINSON HELICOPTER CO R66	**Aircraft Damage:**	Destroyed
Defining Event:	Abrupt maneuver	**Injuries:**	4 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot was conducting a personal flight during daytime visual flight rules conditions with three passengers aboard. A witness who was driving on a nearby highway observed the helicopter flying on an easterly heading about 50 to 100 ft above ground level. The witness stated that the helicopter was initially straight and level but had suddenly made a sharp left turn. The witness briefly lost sight of the helicopter due to trees; when he reestablished visual contact, he observed the helicopter descend and impact terrain.

Postaccident examination of the helicopter revealed no evidence of any pre-existing mechanical malfunction that would have precluded normal operation. The forward left and right control tube attachment bolts at the nonrotating swashplate were not located at the accident site or within the recovered wreckage. The flight control bolts most likely separated during the accident sequence as a result of an overstress fracture. No evidence of preexisting loosening of the attachment nuts, such as substantial thread imprints in the lug bores, was observed. This damage was consistent with the blade grips contacting the mast, commonly referred to as mast bumping, which occurs due to excessive flapping motion of rotor blades (specifically, up-and-down motion of the blade tips). It is likely that, during the flight, the pilot made an abrupt flight control input that resulted in a main rotor blade contacting the tailboom and a subsequent in-flight breakup. The reason for the pilot's abrupt control inputs could not be determined.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The pilot’s abrupt flight control input that led to mast bumping and a subsequent in-flight breakup.

Findings

Aircraft	Main rotor mast/swashplate - Related operating info
Aircraft	(general) - Capability exceeded
Personnel issues	Use of equip/system - Pilot

Factual Information

History of Flight

Enroute-cruise	Abrupt maneuver (Defining event)
Enroute-cruise	Mast bumping
Enroute-cruise	Part(s) separation from AC

On August 1, 2021, about 1251 Pacific daylight time, a Robinson Helicopter Company R66, N7000J, was substantially damaged when it was involved in an accident near Colusa, California. The pilot and three passengers were fatally injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

Recorded automatic dependent surveillance-broadcast (ADS-B) data provided by the Federal Aviation Administration (FAA) showed that, about 1207, the helicopter departed Willows, California, and flew toward the foothills that bordered the western edge of the valley. The ADS-B data also showed that the helicopter turned south while over Elk Creek, California, and overflew Lodoga and Stonyford, California, before turning to the east. The helicopter continued an easterly heading for about 12 minutes and then turned to a southeasterly heading. The helicopter remained on a southeasterly heading for about 2 minutes and then initiated a left turn to an easterly heading when the helicopter was about 0.7 miles west of the accident site, as shown in figure 1. The last recorded data point showed that the helicopter was about 392 ft west of the accident site. The ADS-B data contained no altitude data for the entire flight.

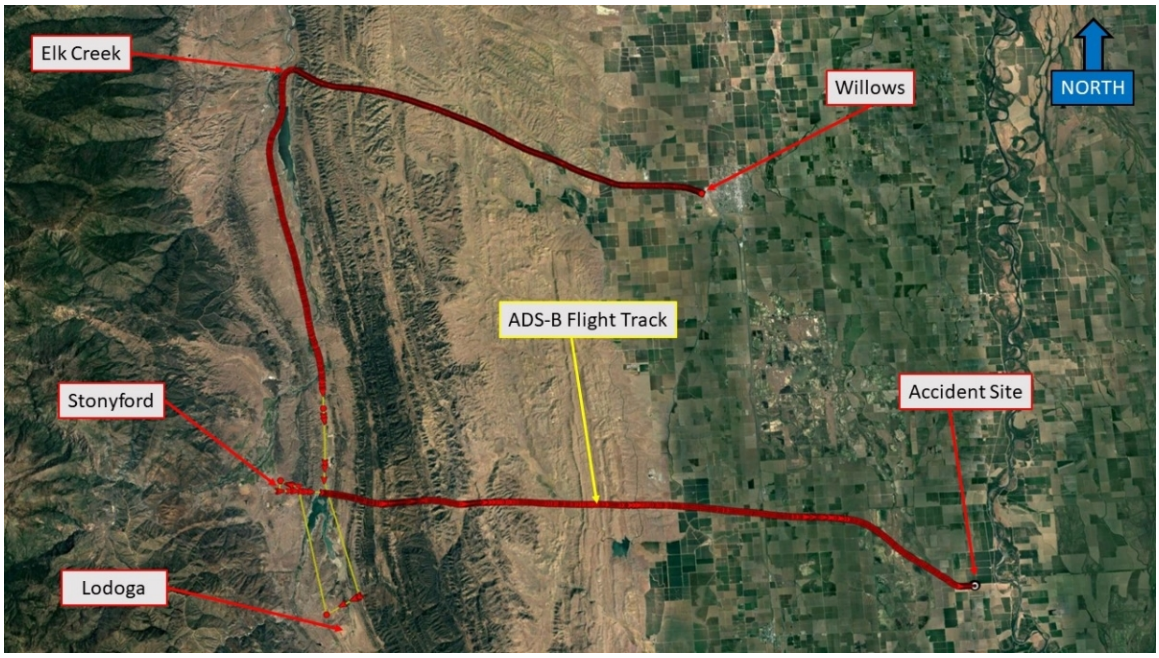

Figure 1. ADS-B flight track for the accident flight.

A witness, who was driving south on a highway about 0.5 miles east of the accident site, reported that he noticed a helicopter flying on an easterly heading about 50 to 100 ft above ground level. The witness stated that the helicopter was initially straight and level but then suddenly made a sharp left turn. The witness briefly lost sight of the helicopter due to trees; when he re-established visual contact, he observed the helicopter "sharply diving," and the helicopter then impacted terrain.

Pilot Information

Certificate:	Private	**Age:**	67,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Front
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	June 1, 2021
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	1568 hours (Total, all aircraft)		

Passenger Information

Certificate:		**Age:**	60,Female
Airplane Rating(s):		**Seat Occupied:**	Rear
Other Aircraft Rating(s):		**Restraint Used:**	
Instrument Rating(s):		**Second Pilot Present:**	No
Instructor Rating(s):		**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:			

Passenger Information

Certificate:		**Age:**	62
Airplane Rating(s):		**Seat Occupied:**	Rear
Other Aircraft Rating(s):		**Restraint Used:**	
Instrument Rating(s):		**Second Pilot Present:**	No
Instructor Rating(s):		**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:			

Passenger Information

Certificate:		**Age:**	71,Male
Airplane Rating(s):		**Seat Occupied:**	Front
Other Aircraft Rating(s):		**Restraint Used:**	
Instrument Rating(s):		**Second Pilot Present:**	No
Instructor Rating(s):		**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	ROBINSON HELICOPTER CO	**Registration:**	N7000J
Model/Series:	R66	**Aircraft Category:**	Helicopter
Year of Manufacture:	2013	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	0411
Landing Gear Type:	None; Skid	**Seats:**	5
Date/Type of Last Inspection:	March 22, 2021 Annual	**Certified Max Gross Wt.:**	
Time Since Last Inspection:	84.32 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	462.52 Hrs at time of accident	**Engine Manufacturer:**	ROLLS-ROYC
ELT:	C126 installed	**Engine Model/Series:**	250-C300/A1
Registered Owner:	On file	**Rated Power:**	300 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

Review of the helicopter's airframe and engine logbooks revealed that, at the time of the most recent annual inspection, the helicopter had a Hobbs meter time, an airframe total time, and an engine total time of 378.2 hours. The helicopter was not equipped with any onboard devices that would have recorded airspeed, altitude, yaw, pitch, roll, or flight control positions.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KOVE,190 ft msl	**Distance from Accident Site:**	23 Nautical Miles
Observation Time:	12:53 Local	**Direction from Accident Site:**	59°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	4 knots /	**Turbulence Type Forecast/Actual:**	Unknown / Unknown
Wind Direction:	240°	**Turbulence Severity Forecast/Actual:**	Unknown / Unknown
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	33°C / 14°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Willows, CA (KWLW)	**Type of Flight Plan Filed:**	None
Destination:	Williams, CA	**Type of Clearance:**	None
Departure Time:	12:07 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	3 Fatal	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	4 Fatal	**Latitude, Longitude:**	39.296803,-122.03939(est)

Examination of the accident site revealed that the helicopter impacted a tomato field. Wreckage debris was scattered among an area that measured 360 ft by 392 ft, as depicted in figure 2.

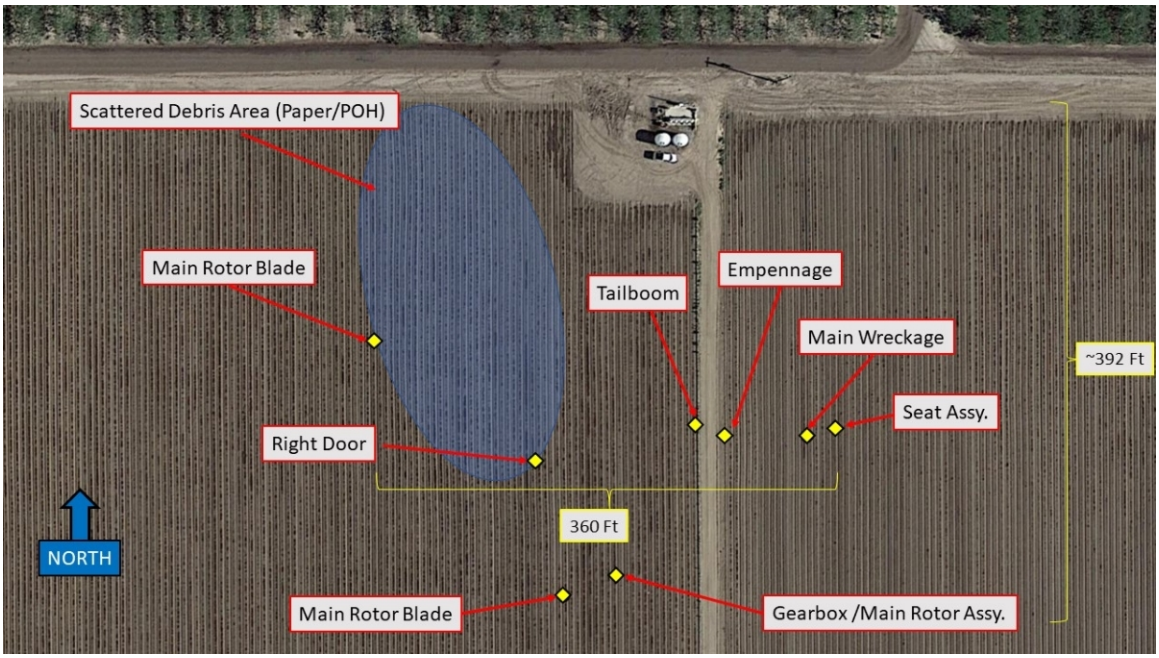

Figure 2. Wreckage diagram of debris area.

A portion of the main rotor blade was located on the western edge of the debris area. The right door was located about 161 ft southeast of the main rotor blade portion. About 112 ft south of the right door, the outboard portion of one blade was found. A ground impression that was about 16 ft long, 8 inches wide, and in a “U” shape was located about 8 ft east of the outboard section of the main rotor blade. The main rotor gearbox and main rotor assembly were located about 5 ft east of the ground impression.

The forward left and right control tubes along with their respective servos and the servo mount structure were located about 3 ft west of the main wreckage. The engine was separated from the fuselage and located adjacent to the fuselage.

Examination of the airframe revealed that the lower windshield frame on the forward lower right area of the fuselage exhibited a dent at the separation edge that was consistent with the size and shape of the leading edge of a main rotor blade. The aft section of the fuselage exhibited buckling, compression, and crushing. The cabin area was separated behind the forward seatbacks and was tethered by various wires. The tailcone was separated at the forward end. The empennage was separated from the tail cone. The driveshaft from the engine to the gearbox was separated near the engine and exhibited twisting with tortional fractures.

Cyclic and collective control continuity was established, but multiple separations consistent with overload were observed throughout the systems. The forward left and right control tube attachment hardware at the nonrotating swashplate was not located at the accident site or within the recovered wreckage. All three control tubes from the servo to the swashplate remained intact with some slight bends and scratches, as shown in figure 3.

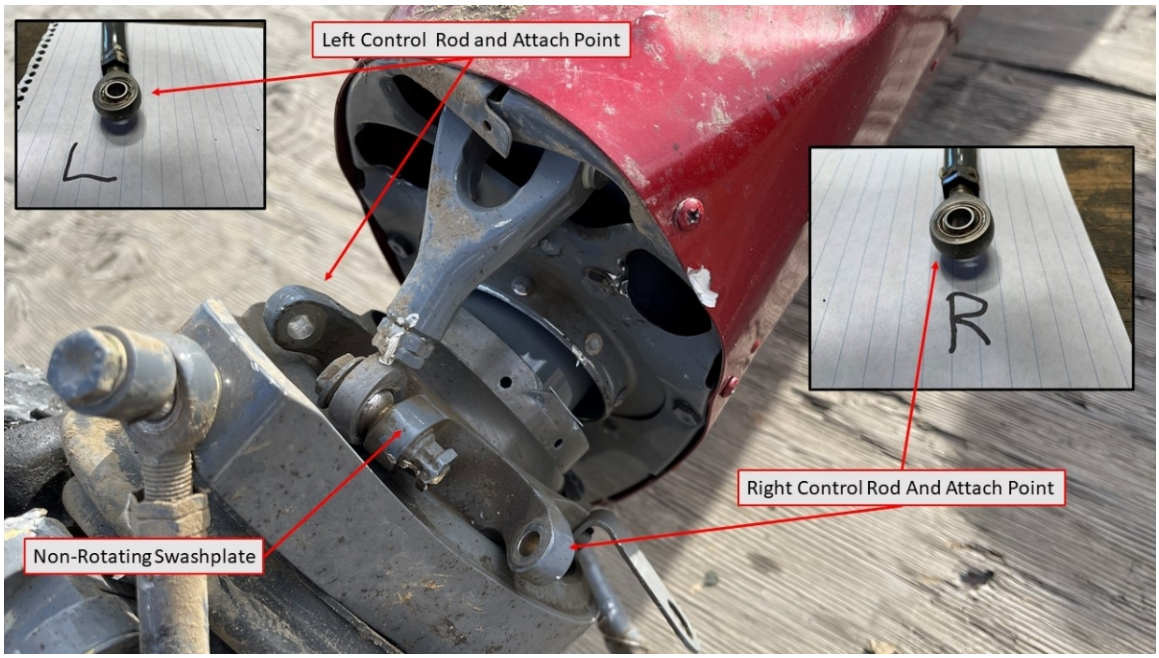

Figure 3. Nonrotating swashplate area and both upper areas of the left and right control tubes.

The tail rotor controls were separated in multiple areas. All areas of separation were consistent with impact damage and/or overload separation. The main rotor blades exhibited varying degrees of damage and were fractured in various areas, as shown in figure 4.

Figure 4. Red and blue main rotor blades.

The engine was separated from the airframe. The turbine module and fuel control unit were fractured and separated from the gearbox. N1 and N2 rotated freely by hand. The upper magnetic chip detector was free of ferrous debris. The lower magnetic chip detector was not located.

The turbine module was disassembled for examination. The gas generator turbine turned freely by hand. The power turbine remained locked in position due to impact damage. The second, third, and fourth stage turbine air foils were intact and undamaged. The engine monitoring unit was located within the wreckage, and all stored data were downloaded. The data showed that the engine was operating at the time of the accident, which can be seen in figure 5.

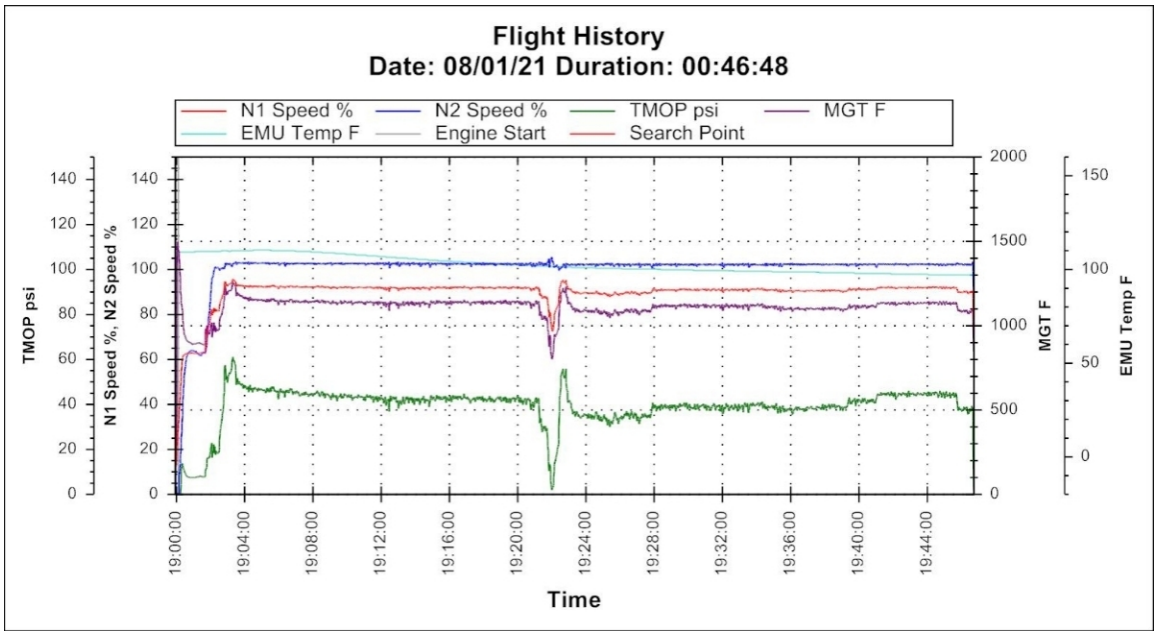

Figure 5. Downloaded engine data for the accident flight.

No evidence of any pre-existing mechanical anomalies were noted with the engine. The main rotor mast assembly, swashplate assembly, flight control servos, flight control upper push-pull tube assemblies, and mast fairing ribs were sent to the NTSB Materials Laboratory for further examination.

The main rotor mast was bent aft, and the pitch change links were fractured on slant planes consistent with ductile overstress fracture. The tube assembly attached to the mast fairing upper rib was separated at the riveted joint just above the mast fairing rib. The rivets on the forward side of the tube assembly were sheared, and the tube portion above the fractured joint was rotated aft. The left and right upper flight control push-pull tubes were bent, and fasteners attaching the left and right control tubes to the lower swashplate assembly were missing. On the control servos, pieces of the lower flight control push-pull tubes were attached at the lower end with fractures on slant planes consistent with ductile overstress fracture. Mounting frame pieces on the control servos also had fractures on slant fracture planes consistent with ductile overstress fracture. The mast fairing ribs were deformed, and contact damage was observed at the edges of through-holes for the flight control upper push-pull tubes.

The forward left and right control attachment lugs on the swashplate were cleaned and examined. No substantial thread imprints were observed on the bores of the attachment holes on the lugs. Remnants shaved from the attachment bolt were located on the lower forward half of the lug at the left side of the hole, and the area between the bolt remnants was rubbed.

The lower portion of the lug with the attachment bolt remnants was examined using a scanning electron microscope. The lower portion of the bolt remnant exhibited dimple features consistent with ductile overstress fracture.

Additional Information

The FAA's *Helicopter Flying Handbook* describes low-G conditions and mast bumping, stating in part the following:

> *Helicopters with two-bladed teetering rotors rely entirely on the tilt of the thrust vector for control. Therefore, low-G conditions can be catastrophic for two-bladed helicopters.…*
>
> *Abrupt forward cyclic input or pushover in a two-bladed helicopter can be dangerous and must be avoided, particularly at higher speeds. During a pushover from moderate or high airspeed, as the helicopter noses over, it enters a low-G condition. Thrust is reduced, and the pilot has lost control of fuselage attitude but may not immediately realize it. Tail rotor thrust or other aerodynamic factors will often induce a roll. The pilot still has control of the rotor disk, and may instinctively try to correct the roll, but the fuselage does not respond due to the lack of thrust. If the fuselage is rolling right, and the pilot puts in left cyclic to correct, the combination of fuselage angle to the right and rotor disk angle to the left becomes quite large and may exceed the clearances built into the rotor hub. This results in the hub contacting the rotor mast, which is known as mast bumping…and the energy and inertia in the rotor system can sever the mast or allow rotor blades to strike the tail or other portions of the helicopter.*

The handbook included an illustration that depicted the hub contacting the rotor mast, as a result of improper corrective action in a low-G condition (figure 6).

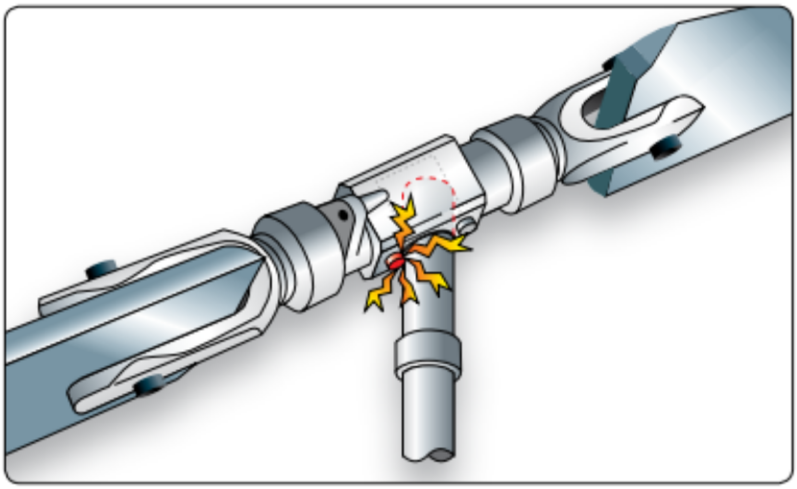

Figure 6. Result of improper corrective action in a low-G condition

Administrative Information

Investigator In Charge (IIC):	Cawthra, Joshua
Additional Participating Persons:	Michael Lenard; Federal Aviation Administration; Sacramento, CA Thom Webster; Robinson Helicopter Company; Torrance, CA Jon Michael; Rolls Royce; Indianapolis, IN
Original Publish Date:	September 7, 2023
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=103602