Aviation Investigation Final Report

Location:	Marianna, Florida	**Accident Number:**	ERA24LA399
Date & Time:	August 23, 2024, 11:30 Local	**Registration:**	N945TC
Aircraft:	BELL TEXTRON CANADA LTD 505	**Aircraft Damage:**	Substantial
Defining Event:	Ground resonance	**Injuries:**	2 None
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

After completing several training maneuvers during a helicopter instructional flight with a flight instructor, the student pilot was tasked to perform a simulated autorotation and to land on the runway. Data recovered from the helicopter's avionics revealed that, during the simulated autorotation, the collective initially remained relatively steady during the descent, and the rotor rpm remained at or above 100%.

Both the flight instructor and the student pilot reported that the touchdown on the runway was soft with no bounce or drift and good heading control as the helicopter entered the forward slide. However, as the helicopter continued to slide down the runway with decreasing groundspeed, it began to bounce laterally and shake violently with increasing severity before it came to a complete stop.

A postaccident examination of the helicopter revealed substantial damage on the tailboom assembly. Examination of the helicopter revealed no mechanical anomaly, and the flight instructor reported no mechanical malfunction or failure that would have precluded normal operation.

The data showed also that, as the helicopter descended through about 30 ft above ground level (agl), the collective began to increase sharply, and the rotor rpm began to drop below 100%. After touchdown on the runway, the collective continued to be increased, resulting in the rotor rpm continuing to decline. This increase in collective control was inconsistent with helicopter's flight manual, which stated that the collective should be lowered after landing.

Although the data showed that the helicopter's horizontal speed, rate of descent, attitude, and vertical acceleration at touchdown were consistent with the parameters for a power-off landing, the data also showed that, as the helicopter subsequently slid along the runway, rapid

oscillations in helicopter pitch, roll, and yaw developed. Divergent oscillations in vertical, lateral, and longitudinal accelerations also occurred, the peak of which was about 3.6 G in the vertical direction when the rotor system had slowed to about 45%.

Further review of the data determined that, as the rotor slowed to about 40%, the rotor vibration frequency started to match with the oscillation frequencies of the helicopter's pitch and roll angles and the lateral, longitudinal, and vertical accelerations as it slid along the runway. It is likely that a resonance developed between the vibrations of the slow-turning rotor system and the vibrations of airframe, resulting in increasing loads on the airframe that exceeded the airframe structural limitations and damaged the tailboom. Had the collective been lowered after touchdown per the rotorcraft flight manual's procedure, it is unlikely that resonance would have occurred.

Probable Cause and Findings

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

The student pilot's failure to maintain rotor rpm during a simulated autorotation, which allowed for a resonance phenomenon to develop. Contributing to the accident was the flight instructor's inadequate monitoring of the student pilot's collective control inputs.

Findings

Personnel issues	Use of equip/system - Instructor/check pilot
Personnel issues	Use of equip/system - Student/instructed pilot

Factual Information

History of Flight

Landing	Ground resonance (Defining event)

On August 23, 2024, about 1130 eastern standard time, a Bell Textron Canada 505 helicopter, N945TC, was substantially damaged when it was involved in an accident near Marianna, Florida. The student pilot and the flight instructor were uninjured. The helicopter was operated as a Title 14 *Code of Federal Regulation* Part 91 instructional flight.

ADS-B data showed that the helicopter departed Dothan Regional Airport (DHN), Dothan, Alabama, flew to the Marianna Municipal Airport (MAI), Marianna, Florida, then performed several circuits in the traffic pattern at MAI. According to the flight instructor and the student pilot, the student pilot then performed a practice autorotation to touchdown on the runway.

The flight instructor reported that the student pilot initiated the landing flare about 80 ft agl with a “good nose-up pitch to bleed airspeed without any aggressive rotor buildup.” The flight instructor stated that, as the helicopter began to settle to about 10 to 15 ft agl, the student pilot applied increased collective with some forward nose cyclic for a level landing at a touchdown speed of about 20 to 25 kts. Both the flight instructor and the student pilot reported that the landing on the runway was soft with no bounce or drift and good heading control as it entered the slide. As the helicopter continued to slide down the runway with decreasing groundspeed, it began to bounce laterally and shake “violently” with increasing severity before it came to a complete stop. A postaccident examination of the helicopter revealed that the tailboom doublers at the attachment point to the truss assembly were deformed.

The helicopter was equipped with an avionics suite that recorded various helicopter position, engine, flight control, attitude, and acceleration parameters. The system automatically adjusted the vertical acceleration recorded values to remove the standard 1G of gravity. The data revealed that, just before the helicopter’s IDLE/FLY switch was switched to the idle position for the simulated autorotation, the helicopter was at an altitude of about 925 ft agl in a slightly nose-down attitude with a slight left bank and an airspeed of about 75 kts. The collective was initially positioned at 33%, the rotor rpm and power turbine speed (NP) were both at 104%, and the gas generator speed (NG) was at approximately 91%. The collective was then lowered to 10%, resulting in a decrease in NG to 82%, while the rotor rpm and NP both remained constant at 104%. During this transition, helicopter’s pitch attitude varied between 2° and 5° nose down, and its airspeed increased to 80 kts.

The IDLE/FLY switch was then put into the IDLE position for the simulated autorotation, and the engine responded by going to idle. The helicopter's pitch was increased, and its airspeed slowed to about 70 kts, which was consistent with the Bell 505 Rotorcraft Flight Manual's recommended speed for best glide. The helicopter continued to operate near 70 kts as it began a descent toward the runway.

As the helicopter descended through about 125 ft agl, its pitch angle leveled off. When the helicopter was about 60 ft agl, its pitch angle increased to about 20° nose up, and the helicopter's vertical descent rate decreased from about 1,600 ft per minute (fpm) to about 800 fpm.

During the flare, the rotor rpm was about 105% and remained stable above 100%, and the collective remained relatively unchanged between 12% and 16% during most of the descent toward the ground. When the helicopter was approximately 30 ft agl, the collective began to increase sharply to 38%, and the rotor rpm began to drop below 100%.

The data showed that, as the helicopter touched down on the runway, the collective continued to be increased, and the rotor rpm decreased to about 67%. Shortly after touchdown, rapid oscillations in helicopter pitch, roll, and yaw developed, and several divergent oscillations in the vertical, lateral, and longitudinal accelerations occurred. These oscillations continued for several seconds, with a peak vertical acceleration of 3.631 Gs, a peak lateral acceleration of 2.718 Gs, and a peak longitudinal acceleration of -2.165 Gs. At the time the peak vertical and lateral accelerations were recorded, the rotor rpm was about 45%, and the peak longitudinal acceleration occurred when the rotor rpm was about 41%.

According to the helicopter manufacturer's review of the data, the helicopter's horizontal speed, rate of descent, attitude, and vertical acceleration at touchdown were consistent with the parameters for a power-off landing. The manufacturer determined that the subsequent divergent oscillations of the vertical, lateral, and longitudinal accelerations, as well as the oscillation frequencies of the helicopter's pitch and roll angles, closely matched the helicopter's rotor vibration frequency at the reduced rotor rpm.

A review of the Bell 505 Rotorcraft Flight Manual revealed the procedure for an in-flight engine failure (requiring an autorotation) prescribed maintaining heading and attitude while lowering the collective to maintain the required 90% to 111% rotor rpm. The procedure also stated that, after landing, the collective should be lowered smoothly.

A review of the operator's flight training syllabus revealed that, for a standard autorotation to a touchdown, the standard was to maintain rotor speed within the rotorcraft flight manual-specified limits throughout the descent and flare.

Flight instructor Information

Certificate:	Commercial; Flight instructor; Military	**Age:**	37,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	5-point
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	Helicopter; Instrument helicopter	**Toxicology Performed:**	
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	November 1, 2023
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	July 22, 2024
Flight Time:	(Estimated) 1081 hours (Total, all aircraft), 25 hours (Total, this make and model), 500 hours (Pilot In Command, all aircraft), 14 hours (Last 90 days, all aircraft), 4 hours (Last 30 days, all aircraft)		

Student pilot Information

Certificate:	Student	**Age:**	30,Male
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	5-point
Instrument Rating(s):	None	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	May 24, 2024
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 51 hours (Total, all aircraft), 51 hours (Total, this make and model), 51 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	BELL TEXTRON CANADA LTD	**Registration:**	N945TC
Model/Series:	505	**Aircraft Category:**	Helicopter
Year of Manufacture:	2024	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	65573
Landing Gear Type:	Skid	**Seats:**	5
Date/Type of Last Inspection:	July 22, 2024 100 hour	**Certified Max Gross Wt.:**	3680 lbs
Time Since Last Inspection:	50 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	149 Hrs at time of accident	**Engine Manufacturer:**	SAFRAN
ELT:	C126 installed, not activated	**Engine Model/Series:**	ARRIUS 2R
Registered Owner:	CAE USA INC	**Rated Power:**	472 Horsepower
Operator:	CAE USA INC	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	MAI,108 ft msl	**Distance from Accident Site:**	1 Nautical Miles
Observation Time:	11:53 Local	**Direction from Accident Site:**	256°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots / 20 knots	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	70°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	30.15 inches Hg	**Temperature/Dew Point:**	29°C / 18°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Dothan, AL (DHN)	**Type of Flight Plan Filed:**	Military VFR
Destination:	Marianna, FL	**Type of Clearance:**	VFR
Departure Time:	10:00 Local	**Type of Airspace:**	Class E

Airport Information

Airport:	Marianna Municipal Airport MAI	**Runway Surface Type:**	Asphalt
Airport Elevation:	110 ft msl	**Runway Surface Condition:**	Dry;Rough
Runway Used:	08	**IFR Approach:**	None
Runway Length/Width:	4763 ft / 100 ft	**VFR Approach/Landing:**	Simulated forced landing;Traffic pattern

Wreckage and Impact Information

Crew Injuries:	2 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	30.84,-85.17(est)

Administrative Information

Investigator In Charge (IIC):	Gibson, Kurt
Additional Participating Persons:	Kevin L. Alewine; FAA/FSDO; Birmingham, AL Robert Potvin; TSB Canada Gary Howe; Bell Textron; Fort Worth, TX
Original Publish Date:	July 2, 2026
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=195393