Aviation Investigation Final Report

Location:	Denver, Colorado	**Accident Number:**	CEN12LA343
Date & Time:	June 2, 2012, 11:35 Local	**Registration:**	N2196F
Aircraft:	Schweizer 269C	**Aircraft Damage:**	Substantial
Defining Event:	Ground resonance	**Injuries:**	2 None
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

The pilot reported that, during an introductory flight, he was conducting a 2-foot hover in the helicopter. An airplane started to taxi in front of the helicopter, so the pilot set the helicopter back down on the ground, left skid first and then the right. The helicopter drifted right as the skid made contact, and the pilot added left cyclic input to remedy the drift as he also lowered the collective. As the skids started to settle apart, the pilot noticed a low frequency vibration that immediately got worse. He determined that the helicopter was entering ground resonance, but the engine and collective parameters were too low to lift the helicopter off of the ground, as indicated in the helicopter's operating procedures. The pilot reduced the throttle to idle and "within seconds, the helicopter had shaken itself apart."

Postaccident testing revealed that all four landing gear dampers failed to meet the manufacturer's serviceable testing specifications, and two dampers were overcharged. Maintenance records indicated that the front dampers had been replaced with overhauled units about 10 months and about 534 flight hours before the accident. The aft dampers had been replaced with overhauled units about 7 months and about 280 flight hours before the accident. A review of the manufacturer's overhaul procedure for the landing gear dampers revealed that the procedure used by the overhaul facility did not include functional testing of the dampers following overhaul, which would have identified the out-of-specification condition before installation. Maintenance procedures required periodic inspection of the landing gear dampers, and the operator stated that the 100-hour inspection procedure was accomplished about 1 month before the accident. The mechanic who accomplished this inspection reported that he used the manufacturer's procedures to complete the inspection. However, the out-of-specification damper conditions were not detected.

As a result of this and a similar accident (CEN12LA353), the helicopter manufacturer has committed to revising the overhaul manual to include testing procedures and criteria for overhauled landing gear dampers.

Probable Cause and Findings

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

The inadequately overhauled landing gear dampers that allowed initiation of a ground resonance event from which the pilot was unable to recover. Contributing to the accident was the overhaul facility's failure to identify the overcharged dampers and a lack of any published acceptance testing criteria for the dampers in the manufacturer's overhaul procedure manual, resulting in the out-of-specification dampers being provided to the operator. Also contributing was the ineffective damper inspection conducted by the operator's maintenance personnel.

Findings

Aircraft	Aux gear (tail/rotorcrft skid) - Damaged/degraded
Aircraft	Aux gear (tail/rotorcrft skid) - Incorrect service/maintenance
Personnel issues	Scheduled/routine maintenance - Maintenance personnel
Organizational issues	Oversight of personnel - Maintenance provider
Organizational issues	Maintenance records - Manufacturer

Factual Information

History of Flight

Prior to flight	Aircraft maintenance event
Landing	Ground resonance (Defining event)

On June 2, 2012, about 1135 mountain daylight time, a Schweizer 269C helicopter, N2196F, entered ground resonance when it set down on the ramp at the Rocky Mountain Metropolitan Airport (BJC), near Denver, Colorado. The commercial pilot and the passenger were uninjured. The helicopter sustained substantial damage to its tail boom during the ground resonance. The helicopter was registered to Top Flight Rotors LLC and operated by TYJ Global under the provisions of 14 Code of Federal Regulations Part 91 as an instructional flight. Day visual flight rules (VFR) conditions prevailed for the flight, which operated on a company VFR flight plan. The local flight was originating from BJC at the time of the accident.

The pilot reported that the flight was an introductory discovery flight for his student passenger. The pilot indicated that he picked the helicopter up into a two-foot skid height hover. An airplane started to taxi in front of the helicopter. The pilot, in part, stated:

> To avoid my downwash disturbing the airplane, or his prop wash from disturbing me, I set the helicopter back onto the ground as a courtesy. I set down the left skid first and then the right, utilizing a two point touch down. When the right skid made contact, the helicopter tried to drift to the right. I put slight left cyclic input in to keep the helicopter from drifting to the right as I lowered collective. As I lowered the collective fully and the skids started to settle apart, I noticed a slight low frequency vibration. Immediately, the vibration got worse, and I determined the helicopter was in the beginning phase of ground resonance. My engine RPM was too low, as was my collective, to pick the helicopter up off the ground to restore the rotor blades to their correct phase in time. With the collective full down, I rolled the throttle to idle to try and get rid of ground resonance. Within seconds, the helicopter had shaken itself apart.

Flight instructor Information

Certificate:	Commercial; Flight instructor	**Age:**	26,Male
Airplane Rating(s):	None	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Instrument helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	January 3, 2012
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	August 11, 2011
Flight Time:	259 hours (Total, all aircraft), 212 hours (Total, this make and model), 240 hours (Pilot In Command, all aircraft), 8 hours (Last 90 days, all aircraft), 4 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

The pilot held a Federal Aviation Administration (FAA) commercial pilot certificate with rotorcraft helicopter and instrument helicopter ratings. He also held a Flight Instructor certificate with rotorcraft helicopter and instrument helicopter ratings. The pilot was issued a second-class FAA airman medical certificate, which listed no limitations, on January 3, 2012. The operator reported that the pilot had accumulated 259 hours of total flight time and 212 hours of flight time in the same make and model as the accident helicopter.

Aircraft and Owner/Operator Information

Aircraft Make:	Schweizer	**Registration:**	N2196F
Model/Series:	269C	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	S1647
Landing Gear Type:	Skid	**Seats:**	3
Date/Type of Last Inspection:	May 17, 2012 100 hour	**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	1720 Hrs at time of accident	**Engine Manufacturer:**	LYCOMING
ELT:	Not installed	**Engine Model/Series:**	HIO-360-D1A
Registered Owner:	TOP FLIGHT ROTORS LLC	**Rated Power:**	205 Horsepower
Operator:	TYJ Global	**Operating Certificate(s) Held:**	None

N2196F, was a 1994 Schweizer 269C helicopter with serial number S1647. The helicopter was equipped with fixed skids for landing gear and was configured for two occupants. The helicopter was powered by

a direct drive, horizontally opposed, fuel injected, air-cooled, four-cylinder engine. The engine was a Lycoming HIO-360-D1A, serial number L-26088-51A, and was driving a three-blade main rotor assembly.

The maintenance records noted that the front landing gear struts were replaced at a Hobbs time of 1185.6 on August 8, 2011, and the rear landing gear struts were replaced at a Hobbs time of 1439.7 on November 14, 2011.

The helicopter manufacturer's maintenance procedures require that the forward and aft landing gear dampers are checked for operation, condition, and extension at each 100 hour inspection. In the event that the dampers do not meet the extension requirements, the dampers must be repaired or recharged.

The helicopter's most recent inspection was a 100-hour inspection, which was completed on May 17, 2012. According to the operator, the helicopter had accumulated 1,720 hours of total flight time at the time of the accident.

The mechanic who performed the 100-hour inspection stated that the periodic inspection procedure specified in maintenance manual was used to complete the inspection of the dampers and all measurements were found to be within limits.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KBJC,5670 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	10:50 Local	**Direction from Accident Site:**	202°
Lowest Cloud Condition:	Scattered / 7000 ft AGL	**Visibility**	50 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	4 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	23°C / 4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Denver, CO (BJC)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Denver, CO (BJC)	**Type of Clearance:**	None
Departure Time:	11:35 Local	**Type of Airspace:**	

At 1050, the recorded weather at BJC was: wind variable at 4 knots; visibility 50 statute miles; sky condition scattered 7,000 feet, scattered 20,000 feet; temperature 23 degrees C; dew point 4degrees C; altimeter 30.00 inches of mercury.

Airport Information

Airport:	Rocky Mountain Metro Airport BJC	**Runway Surface Type:**	
Airport Elevation:	5673 ft msl	**Runway Surface Condition:**	
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

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:**	39.913333,-105.11(est)

The helicopter came to rest upright, located on a parking pad adjacent to a taxiway at BJC. The helicopter sustained damage to the main rotor blades and tail rotor blades. The tail boom sustained damage at its aft end consistent with a main rotor strike with it. The main rotor mast separated from its upper aft fuselage structure and the mast came to rest behind and to the left of the fuselage as viewed from the tail rotor looking forward. A postaccident examination conducted by FAA inspectors did not reveal any preimpact mechanical failures or malfunctions.

Medical and Pathological Information

The pilot's postaccident toxicology testing was negative for the tests performed.

Tests and Research

On July 3, 2012, testing was conducted on the landing skid dampers at the manufacturer's facilities under supervision of a FAA Rochester Flight Standards District Office representative. During testing, a specified load profile is applied to the subject damper and the resulting displacement (stoke) is

measured. The load vs. displacement profile is compared to a specification in order to determine the status of the damper.

The damper identified as left forward, part number 269A3150-19, serial number HT13324-1, was intact with minor bending to the upper bearing lug. The load stroke test showed that it was out of limits on the compression stroke at the lower pressure test point. It was within the ultimate load range.

The damper identified as right forward, part number 269A3150-19, serial number HT13324-2, was intact with no obvious damage or leakage. The load stroke test showed that it was out of limits on the compression stroke at the lower pressure test point. It was within the ultimate load range.

The damper identified as left rear, part number 269A3150-21, serial number HT13443-1, was intact. The load stroke test indicated a high out of limits condition at the ultimate load point.

The damper identified as right rear, part number 269A3150-21, serial number HT13443-2, was intact and exhibited a dent in the lower barrel. The load stroke test indicated a bulge in the plot on the chart consistent with barrel diameter change due to the dent. This damper failed the test due to a high ultimate load point.

Additional Information

The FAA Rotorcraft Flying Handbook noted that ground resonance develops when the rotor blades move out of phase with each other and cause the rotor disc to become unbalanced. This can occur when a helicopter touches down firmly on one corner of the landing gear (skid). This condition can lead to a violent, uncontrollable oscillation. In the event that the rotor speed is low, the corrective action to stop ground resonance is to close the throttle immediately and fully lower the collective to place the blades in low pitch. On the other hand, if the rotor speed is in the normal operating range, the helicopter should be brought off the ground into a hover to allow the blades to automatically realign.

The helicopter manufacturer issued a safety advisory, dated February 22, 2012, regarding ground resonance events. The advisory noted that landing gear dampers act to slow airframe rocking motion, which may be initiated by a pronounced ground contact on one landing skid. The advisory warned that ground resonance can occur when landing dampers do not meet design specifications and that helicopters are to be maintained in accordance with current maintenance manuals.

The maintenance manual overhaul procedure for the landing gear dampers, current at the time of the accident, provided for the inspection, cleaning, reassembly, and recharging of the components. The overhaul procedure did not provide for functional/operational testing of the dampers following overhaul. The procedure noted that incorrect fluid levels, improper pressure, or inoperable valve function will reduce the effectiveness of the dampers and may lead to ground resonance.

A representative of the repair station that overhauled the accident dampers stated that the steps and

procedures called out in the helicopter's maintenance manuals are what are followed when overhauling or repairing these dampers. Every step during the repair/overhaul process is monitored by a trained and experienced mechanic and an experienced inspector. He further indicated that nowhere within any of the manuals is there a provision, requirement, or any instructions, as to performing a "Test" on any overhauled damper.

Administrative Information

Investigator In Charge (IIC):	Malinowski, Edward
Additional Participating Persons:	Joseph Fernandez; Federal Aviation Administration; Denver, CO Steven Gleason; Sikorsky Aircraft Corp; Horseheads, NY
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Note:	
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