

Aviation Investigation Final Report

Location:	Boise, Idaho	Accident Number:	WPR13LA382
Date & Time:	August 22, 2013, 10:50 Local	Registration:	N922MA
Aircraft:	Cessna 206	Aircraft Damage:	Substantial
Defining Event:	Landing gear collapse	Injuries:	5 None
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled		

Analysis

The airplane was routinely used to transport passengers to and from remote unpaved, and sometimes rough, landing strips. The pilot reported that the landing at one of those unpaved strips was uneventful. Several passengers and their baggage were boarded, and the airplane then departed uneventfully. After a normal touchdown on the smooth, paved runway at the airplane's destination, when the pilot lowered the nose, the airplane began to vibrate severely, and the pilot was unable to maintain directional control. The airplane veered to the left, the nose landing gear collapsed, and the right wing contacted the runway before the airplane came to a stop near the edge of the runway. Examination of the nose landing gear components did not reveal any preimpact damage that could be associated with the vibration or failure of the nose landing gear. Although not causal to the nose landing gear failure, the nose landing gear steering collar was found to contain a high-cycle fatigue crack, but no further information was available to determine the age of the crack or the effectiveness of the previous inspection.

Nose gear shimmy, which is an abnormal, and often violent, vibration of the nose wheel, can result in failure of the nose landing gear. It is usually caused by looseness of the nose wheel support mechanism or an unbalanced wheel. However, there were no reports of recent nose gear shimmy on the airplane, and damage precluded any postaccident determination of the airplane's susceptibility to shimmy. Although operations on rough, unpaved runways can induce higher and different nose landing gear loads than do operations from smooth, paved runways, there was no evidence to directly link the operator's use of unpaved runways with the failure of the nose landing gear.

Probable Cause and Findings

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

The mechanical failure of the nose landing gear for reasons that could not be determined because impact damage prevented a complete examination.

Findings

Aircraft

Nose/tail landing gear - Failure

Factual Information

History of Flight	
Landing-landing roll	Landing gear collapse (Defining event)

On August 22, 2013, about 1050 mountain daylight time, a Cessna TU206F, N922MA, was substantially damaged during landing on runway 10L at Boise Air Terminal/Gowen Field (BOI), Boise, Idaho. The commercial pilot and the four passengers were uninjured. The backcountry charter flight was operated by McCall Air, and was conducted under the provisions of Title 14 Code of Federal Regulations Part 135. Visual meteorological conditions prevailed, and no Federal Aviation Administration (FAA) flight plan was filed for the flight.

According to the pilot, he had flown to Wilson Bar USFS Airport (C48) Dixie, Idaho, to pick up the backcountry passengers and transport them to BOI. The landing at, and departure from, C48 were uneventful, as was the flight to BOI. The approach to, and initial touchdown on, runway 10L at BOI were uneventful. However, when the pilot lowered the nose landing gear (NLG) to the runway, the airplane began to vibrate severely, and the pilot was unable to maintain directional control. The airplane veered left, and came to a stop near the edge of the runway. The pilot secured the airplane and all persons exited safely. Examination of the airplane revealed that the NLG had collapsed, and the cowling, propeller, and the right wing had contacted the runway. The damaged NLG components were retained by the NTSB for detailed examination.

Certificate:	Commercial	Age:	64
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	3-point
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 2 With waivers/limitations	Last FAA Medical Exam:	May 21, 2013
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	July 22, 2013
Flight Time:	6837 hours (Total, all aircraft), 4568 hours (Total, this make and model), 6817 hours (Pilot In Command, all aircraft), 175 hours (Last 90 days, all aircraft), 108 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

Pilot Information

FAA records indicated that the pilot held a commercial pilot certificate that included airplane single- and multi-engine land ratings. According to information provided by the pilot, he had approximately 6,837 total hours of flight experience, including about 4,568 hours in the accident airplane make and model. His most recent flight review was completed in July 2013,

and his most recent FAA second-class medical certificate was issued in May 2013.

Aircraft Make:	Cessna	Registration:	N922MA
Model/Series:	206 TU206F	Aircraft Category:	Airplane
Year of Manufacture:	1975	Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	U20603467
Landing Gear Type:	Tricycle	Seats:	6
Date/Type of Last Inspection:	August 6, 2013 Continuous airworthiness	Certified Max Gross Wt.:	3600 lbs
Time Since Last Inspection:		Engines:	1 Reciprocating
Airframe Total Time:	6706 Hrs at time of accident	Engine Manufacturer:	Continental
ELT:	C126 installed, not activated	Engine Model/Series:	TSI0520
Registered Owner:	JLS II LLC	Rated Power:	310 Horsepower
Operator:	McCall Air	Operating Certificate(s) Held:	On-demand air taxi (135)

Aircraft and Owner/Operator Information

FAA information indicated that the airplane was manufactured in 1976, and was equipped with a Continental Motors TSIO-520 series engine. Operator-provided information indicated that the airplane had a total time (TT) in service of about 6,706 hours. The most recent completed element of the continuous inspection program was completed on August 6, 2013, and the airplane had accumulated about 52 hours in the period between that inspection and the accident.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	BOI,2487 ft msl	Distance from Accident Site:	0 Nautical Miles
Observation Time:	10:53 Local	Direction from Accident Site:	
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	10 knots / None	Turbulence Type Forecast/Actual:	/
Wind Direction:	160°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.98 inches Hg	Temperature/Dew Point:	31°C / 8°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Dixie, ID (C48)	Type of Flight Plan Filed:	Unknown
Destination:	Boise, ID (BOI)	Type of Clearance:	None
Departure Time:	09:25 Local	Type of Airspace:	

The 1053 BOI automated weather observation included winds from 160 degrees at 10 knots, visibility 10 miles, clear skies, temperature 31 degrees C, dew point 8 degrees C, and an altimeter setting of 29.99 inches of mercury.

Airport Information

Airport:	Boise Air Terminal BOI	Runway Surface Type:	Asphalt
Airport Elevation:	2871 ft msl	Runway Surface Condition:	Dry
Runway Used:	10L	IFR Approach:	None
Runway Length/Width:	10000 ft / 150 ft	VFR Approach/Landing:	Traffic pattern

FAA information indicated that C48 was equipped with a single dirt/turf runway that measured 1,500 by 50 feet. Runway 10L at BOI was asphalt, and measured 10,000 by 150 feet.

meenage and impact information			
Crew Injuries:	1 None	Aircraft Damage:	Substantial
Passenger Injuries:	4 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	5 None	Latitude, Longitude:	43.564167,-116.222778

Wreckage and Impact Information

The airplane came to rest upright, with its NLG collapsed, near the north (left) edge of the runway, and about 1,400 feet beyond the landing threshold. The outboard end of the right wing incurred scraping and buckling damage as a result of contact with the runway.

The NLG strut was folded aft under the fuselage, and the upper link of the torque assembly was fractureseparated from the strut. The upper end of the upper link of the torque link was fracture-separated from the landing gear, and the diagonal braces were fractured and/or and gouged. No non-impact damage of the nose wheel steering mechanism was noted. A detailed damage description is included in a subsequent section of this report.

Additional Information

Nose Landing Gear Design

The NLG can be considered as consisting of two primary sections; the trunnion assembly, and the shock strut assembly. The trunnion assembly affixes to the airframe, and includes the shock strut cylinder, two diagonal braces, the steering actuator, and the shimmy dampener.

The shock strut assembly mates with the trunnion assembly, and consists of the shock strut piston, and the fork, wheel, and tire assembly. The shock strut assembly pivots about an axis approximately parallel to the airplane vertical axis, to enable rotation for nose wheel steering. A torque link assembly enables control of the rotation of the shock strut assembly. The upper torque link attaches to the steering collar on the trunnion assembly, while the lower link attaches at the junction of the strut piston and fork assemblies. The attach bolt holes in the torque links are bushed with NAS77 bushings

Nose Landing Gear Inspections and Maintenance

The operator reported that the airplane was maintained using a manufacturer's/continuous airworthiness inspection program.

According to the operator, most of the NLG components were the original components from when the airplane was manufactured. Review of the recent maintenance records indicated that the wheel bearings

were replaced about 2 years before the accident, and had accumulated about 812 hours TT.

The most recent NLG maintenance was completed on August 22, 2012, when the airplane had a TT of about 6,354 hours. At that time, the upper torque link and its hardware were replaced. At the time of the accident, that component had accumulated about 352 hours in service.

In addition to the standard inspections, in 2011 Cessna published a "Supplemental Inspection (SI) 32-20-01" (Title: "Nose Landing Gear Inspection") applicable to the 206 series airplanes from model years 1969 to 1976. This SI was applicable to the accident airplane. The "Initial" and "Repeat" inspection intervals were 3,000 hours or 5 years. The stated purpose of the SI was to "ensure structural integrity of the nose gear torque links, drag link, bolts, nose gear fork and collar." Specific inspection items included dimensional checks, checks for wear, and inspecting for "bent bolts" and cracks in the collar assembly. Neither deformed bolts nor cracks of any size were permitted.

According to the operator's maintenance manager, although not explicitly cited in the maintenance records entries, the SI was accomplished at least twice, on September 8, 2010, and most recently on August 22, 2012. Based on the maintenance records, that SI was most recently accomplished about 1 year, and 352 hours in service, before the accident, which was well within the specified inspection intervals.

Nose Landing Gear Laboratory Examination

The NLG components were sent to the Cessna Material and Process Engineering laboratory in July 2015 for examination, with federal oversight provided by FAA personnel. The intent was to characterize the damage and, if possible, determine the cause of the NLG collapse. An initial exam was conducted in late July 2015, and the detailed exam was completed in late September 2015. During that interim period, the NLG assembly was stored inside, first at the recovery facility, then at another facility, and then from July 22, 2015 on, at the Textron Aviation Materials and Process laboratory.

All observed components were the proper parts/part numbers. All required components and hardware were present and accounted for. The shimmy dampener was intact, filled with fluid, and functioned normally under manual manipulation. The examination noted the absence of any S-1450-6B14-010 shims at the attach point of the upper torque link to the steering collar, but the shim quantity is variable as a function of the fit between the two components. Therefore, a secure fit with no shims is an allowable configuration. Damage to the components precluded a determination of their pre-accident fit.

The two lugs on the steering collar had fractured, which liberated the upper end of the upper torque link from the collar. The lug failure modes were determined to be ductile overload. No pre-existing damage or other material abnormalities of the lugs were observed. However, on the right outboard lug, a "shadow" in the topcoat paint was consistent with the presence of an approximately 0.5967 inch diameter object, located approximately 0.1 inch off-center from the 0.377 inch diameter machined hole in the lug, at the time of the topcoat application. The shadow off-center direction was approximately the same as the lug failure direction. For reference purposes, the specified AN960-416 washer has an outside diameter (OD) of 0.500 inches, and the (absent) S-1450 shim have an OD of approximately 0.874 inches. The reason for this shadow could not be determined.

The attach bolt, nut, and cotter key for that joint remained installed in the upper torque link. The fact that this attach hardware was undisturbed, combined with the absence of the two S-1450 shims, enabled the determination that those shims had not been installed at the time of the accident. The 0543047-2 spacer in the upper torque link was immobilized in place in the link, which was not in accordance with the design. Neither the timing of, nor the reason for the immobilization could be determined; it could have been a result of impact damage, or exposure to a corrosive environment or substance, either in service or subsequent to the accident. The paint on the upper link was noticeably cleaner and brighter than that of the lower link; this was consistent with its recent replacement.

The upper torque link remained attached to the lower link, which remained attached to the nose gear fork. The 0543047-1 spacer in the lower torque link moved freely in the link, per design.

The upper lugs of the right diagonal brace had fracture-separated from the trunnion; the attach hardware remained in the trunnion, and the separated lug segments remained captive by the hardware. The lower end of the left diagonal brace and its mating lug on the trunnion were deformed. The head of that attach bolt was fracture-separated. The bolt fracture face did not contain any evidence of pre-existing abnormalities or deficiencies; the fracture was consistent with ductile overload. The upper attach bolt was bent but otherwise intact.

Both diagonal braces contained gouges at their lower ends. The gouges were consistent with damage that occurred either during the deformation of the assembly as a result of the NLG collapse, or during the subsequent recovery efforts.

Once the steering collar was cleaned, a crack was observed on its upper circumference. The crack measured approximately 0.35 inches long, and was oriented approximately vertically with respect to the airplane, and radially with respect to the collar. Microscopic examination revealed that the crack was high-cycle fatigue, but no geometric discontinuities, corrosion, or other features were present at the initiation site of the crack. The metallurgy of the collar was per the design specifications.

The investigation was unable to determine the age of the crack, or whether the crack had been present and undetected during the operator's most recent NLG inspection. In addition, because the age and service time of the crack was unknown, the investigation was unable to determine whether the manufacturer's NLG inspection intervals were adequate.

The collar normally mounted on the upper strut, and a roller bearing assembly between the two enabled the collar to rotate on that strut. During the examination, the roller bearing did not rotate freely in its installed position. The roller bearing, as well as the races on the strut and collar, exhibited light corrosion, consistent with insufficient lubrication and protection from the elements. The timing of the roller bearing immobilization and corrosion could not be determined; it could have occurred either in service, or subsequent to the accident.

Nose Gear Shimmy

The FAA Aviation Maintenance Technician Handbook (H-8083-31) defines shimmy as "Abnormal, and often violent, vibration of the nose wheel of an airplane, and states that shimmying "is usually caused by looseness of the nose wheel support mechanism or an unbalanced wheel."

Shimmy, particularly when left uncorrected, can damage components, with the potential to result in a component or system failure. Operations on unprepared runways or rough pavement can impose different and/or higher loads than operations on smooth runways, which can accelerate wear and thus susceptibility to shimmy. Operations on unprepared runways or rough pavement can also mask shimmy.

In 1984, Cessna issued Service Information Letter (SIL) SE84-21, which provided maintenance-related guidance for detecting and correcting the causes of shimmy. The SIL stressed the importance of eliminating improper system freeplay (looseness), as well as other abnormalities. The accident-induced damage precluded any determination of the accident airplane's overall NLG condition with regard to shimmy susceptibility. The pilot did not report any previous shimmy problems with the airplane. He reported that the previous landing and takeoff at C48 were normal, and that the accident landing was normal until the vibration and loss of control occurred.

Administrative Information

Investigator In Charge (IIC):	Huhn, Michael
Additional Participating Persons:	Jack Pahlas; FAA FSDO; Boise, ID
Original Publish Date:	December 17, 2015
Last Revision Date:	
Investigation Class:	<u>Class</u>
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=87846

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