Aviation Investigation Final Report

Location:	Paso Robles, California	**Incident Number:**	WPR16IA025
Date & Time:	November 7, 2015, 12:34 Local	**Registration:**	N999VX
Aircraft:	CIRRUS DESIGN CORP SR22T	**Aircraft Damage:**	Minor
Defining Event:	Landing gear collapse	**Injuries:**	5 None
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

The student pilot was landing the airplane when, during the landing roll, the nose landing gear collapsed. Examination revealed that the nose landing gear had separated, and metallurgical testing showed that the failure was the result of high stress fatigue cracking due to sideways bending from one side. The crack was through the strut tube located at the forward edges (toes) of the gusset tube where it welds to the main strut tube. No other anomalies were identified with the landing gear. Further testing revealed that shimmy events or nonstandard towing procedures could result in the cracks and eventual separation of the nose gear. Similar incidents have occurred involving the same nosewheel design. As a result, the airplane manufacturer released a service bulletin to inspect for cracking and a service advisory related to appropriate towing procedures. Additionally, the manufacturer updated the design of the nose landing gear to increase the strength of the strut tube.

Probable Cause and Findings

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

The failure of the nose landing gear due to unanticipated fatigue loads.

Findings

Aircraft	Nose/tail landing gear - Fatigue/wear/corrosion
Aircraft	Nose/tail landing gear - Design
Aircraft	Nose/tail landing gear - Capability exceeded

Factual Information

History of Flight

Landing-landing roll	Landing gear collapse (Defining event)

This report was modified on January 29, 2018. Please see the docket for this accident to view the original report.

On November 7, 2015, at 1234 Pacific standard time, a Cirrus SR22T, N999VX, sustained minor damage during the landing roll at Paso Robles Airport, Paso Robles, California. The airplane was registered to PHD Ventures Inc., and operated under the provisions of 14 *Code of Federal Regulations* Part 91. The flight instructor, student pilot, and three passengers were not injured. Visual meteorological conditions prevailed and no flight plan was filed.

According to the flight instructor, the student pilot was flying the airplane and the airplane touched down normally on the main gear. The student pilot then lowered the nose of the airplane and the nose landing gear collapsed.

Post incident examination revealed that the nose landing gear had separated. The nose landing gear consists of a main strut tube and two gusset tubes near the top portion of the main strut tube. The separation involved a crack beginning at the edge of the side gusset tubes weld to the main strut tube. Prior to the incident, a similar event had occurred, NTSB Incident WPR15IA252, and following this event, additional incidents occurred, including one in Japan.

The NTSB Materials Laboratory examined the nose landing gear strut and determined that the failure of the landing gear was the result of high stress fatigue cracking due to sideways bending from one side. No mechanical or metallurgical anomalies were noted with the landing gear.

On March 7, 2016, Cirrus Design Corporation issued Service Advisory Letter SA 16-03, which denoted the following:

- Cracks have been discovered on the nose landing gear strut assembly at the welds between the strut tube and the LH and RH gusset tubes.
- A visual inspection of the welds between the strut tube and the LH and RH gusset tubes for cracks must be performed every time the engine cowling is removed.
- If cracks are found, the aircraft is prohibited from flight until the nose landing gear strut assembly is replaced. (Refer to AMM-32-20).

Additionally, Cirrus Design Corporation performed structural testing of the nose landing gear.

Based on the data provided by the NTSB metallurgy lab, and a video of the Japan incident airplane experiencing nose landing gear shimmy 6 months before the nose gear collapsed, Cirrus explored two different methods of producing side loads in the nose landing gear. The first was through taxi and towing, the second through shimmy. Flight testing showed that significant side loads on the nose landing gear would develop during a shimmy event.

As a result of the testing, Cirrus did the following:

On April 12, 2016, Service Bulletin SB2X-32-22, "NOSE GEAR – Nose Landing Gear Strut Assembly Inspection," was released to inspect all the nose landing gear in the field for cracks in the welds between the strut tube and the LH and RH gusset tubes. In addition to the one-time inspection required by Service Bulletin SB2X-32-22, Cirrus added a post-shimmy inspection to Chapter 5-50 Unscheduled Maintenance Checks of the Aircraft Maintenance Manual (AMM). Similar to the hard/overweight landing inspection, this post-shimmy inspection would look specifically for cracks at the gusset welds exactly as noted in the Service Bulletin.

On April 12, 2016, based on the potential for damage to the nose landing gear due to loading from non-standard and abusive tug operation, Service Advisory SA16-05, "Aircraft Towing Guidance," was released offering aircraft towing guidance. This guidance includes the following;

- When towing aircraft, do not stop/start abruptly, especially when the tow bar is at an angle greater than 45° either side of center.

- When positioning the aircraft with a towing vehicle, the angle of the tow bar must be less than 45° either side of center for both pulling and pushing. Hand towing must be used if angles greater than 45° either side of center are needed for positioning.

- Do not tow aircraft at speeds higher than 15 mph.

On July 14, 2017, Cirrus Design Corporation Service Bulletin SB2X-32-22R1 was issued. The bulletin, which is considered mandatory, was revised to update Compliance, Effectivity, Purpose, Manpower Requirements, and Accomplishment instructions. The bulletin specifically states, "Operators who have successfully complied with the original release of this service bulletin, dated April 12, 2016, must complete Revision 1 of this Service Bulletin in its entirety, and must continue to perform this Service Bulletin every 50 hours thereafter until termination action occurs.

On January 5, 2018, Cirrus Design Corporation Service Bulletin SB2X-32-22R2 was issued. The bulletin, which is considered mandatory, was revised to update Compliance and Effectivity. The bulletin specifically states, "Operators who have successfully complied with the original release of this service bulletin, dated April 12, 2016, must complete Revision 2 of this Service Bulletin in its entirety, and must continue to perform this Service Bulletin every 50 hours thereafter until termination action occurs.

On July 14, 2017, Cirrus Design Corporation Service Bulletin SB2X-32-23, which Cirrus considered to be mandatory, entitled "NOSE GEAR – Nose Wheel Shimmy Reduction," was issued. The bulletin noted that on affected airplanes, nose wheel shimmy may exist on aircraft equipped with Beringer wheels. The bulletin states that a nose tire vibration due to imbalance or tire damage can be mistaken for NLG shimmy. However, it is advisable that both conditions be examined closely and considered tandem

during aircraft inspection. The bulletin contains instructions for the adjustment of the nose tire pressure and force required to rotate the nose wheel fork.

On January 5, 2018, Cirrus Design Corporation issued revised Service Bulletin SB2X-32-23R1. The bulletin, which is considered mandatory, was revised to update Effectivity, Purpose, and Accomplishment Instructions. The bulletin states that operators who have successfully complied with the original release of this Service Bulletin, dated July 14, 2017, must complete Revision 1 of this Service Bulletin in its entirety. The Service Bulletin contains instructions for the adjustment of the nose tire pressure and the verification of the force required to rotate the nose wheel fork.

On July 14, 2017, Cirrus Design Corporation issued Cirrus Service Advisory (SA) SA17-08, entitled "Possible Cracking at Nose Land Gear Fillet Welds." The SA revealed that cracks had been discovered on some nose landing gear (NLG) strut assemblies at the fillet welds between the strut tube and the LH and RH gusset tubes. These cracks had led to the collapse of the NLG assemblies. The SA further revealed that each of the aircraft involved had a history of excessive nose wheel shimmy following touchdown of the nose landing gear. The SA defined "nose wheel shimmy" as "a lateral oscillation or wobble of the NLG resulting in a shaking feeling throughout the cabin of the aircraft that can vary in intensity." This is normally encountered during the landing roll-out and will subside as speed is reduced. Cirrus noted in the "Actions" section of the SA that nose wheel shimmy can be reduced or eliminated by lowering the tire pressure. Prior to the next flight, adjust the tire pressure on the nose landing gear to 40 – 50 psi (276 – 344 kPa).

On January 5, 2018, Cirrus Design Corporation issued revised Service Advisory SA17-08R1 (revision 1). The Advisory was issued to update Effectivity and the NLG tire pressure as outlined in SA17-08, dated July 14, 2017. Cirrus noted in the "Actions" section of the SA that nose wheel shimmy can be reduced or eliminated by lowering the tire pressure. Prior to the next flight, adjust the tire pressure on the nose landing gear to 30 – 35 psi (207 – 241 kPa).

Cirrus Aircraft also incorporated specific emphasis and recommendations on how to further discourage shimmying on landing and actions to be taken if the situation occurs on landing in their pilot training program. These incorporations are included in the Landing Standardization Course. Maintenance guidance is also available to mechanics following a shimmy event.

To increase the strength of the weld in the critical area on the nose landing gear, the thickness of the main strut tube was analyzed with an increased wall thickness from 0.125-inch to the full thickness of 0.156-inch. The result of the analysis was an increase (3-5%) in the local stress levels in the static analysis. This design change has been made for all new and replacement gear.

Student pilot Information

Certificate:	None	**Age:**	48,Male
Airplane Rating(s):	None	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	None	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	140 hours (Total, all aircraft), 140 hours (Total, this make and model)		

Flight instructor Information

Certificate:	Commercial; Flight instructor	**Age:**	24,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	April 30, 2013
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	November 1, 2015
Flight Time:	1000 hours (Total, all aircraft), 390 hours (Total, this make and model), 900 hours (Pilot In Command, all aircraft), 94 hours (Last 90 days, all aircraft), 17 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	CIRRUS DESIGN CORP	**Registration:**	N999VX
Model/Series:	SR22T NO SERIES	**Aircraft Category:**	Airplane
Year of Manufacture:	2014	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	0871
Landing Gear Type:	Tricycle	**Seats:**	5
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	3600 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:		**Engine Manufacturer:**	Continental Motors
ELT:		**Engine Model/Series:**	TSIO-550-K
Registered Owner:	On file	**Rated Power:**	315 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	PRB,839 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	12:53 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	4 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	240°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.04 inches Hg	**Temperature/Dew Point:**	70°C / 37°C
Precipitation and Obscuration:			
Departure Point:	Santa Monica, CA (SMO)	**Type of Flight Plan Filed:**	None
Destination:	Paso Robles, CA (PRB)	**Type of Clearance:**	VFR flight following
Departure Time:	11:45 Local	**Type of Airspace:**	Class E

Airport Information

Airport:	PASO ROBLES MUNI PRB	**Runway Surface Type:**	Asphalt
Airport Elevation:	838 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	31	**IFR Approach:**	None
Runway Length/Width:	4701 ft / 100 ft	**VFR Approach/Landing:**	Traffic pattern

Wreckage and Impact Information

Crew Injuries:	2 None	**Aircraft Damage:**	Minor
Passenger Injuries:	3 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	5 None	**Latitude, Longitude:**	35.672779,-120.626945

Administrative Information

Investigator In Charge (IIC):	Dunks, Kristi
Additional Participating Persons:	Mark Mitchell; Federal Aviation Administration; San Jose, CA Brannon Mayer; Cirrus Aircraft; Duluth, MN
Original Publish Date:	March 19, 2018
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this incident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=92306