National Transportation Safety Board
Aviation Accident Final Report

Location:	Battle Creek, MI	**Accident Number:**	CEN11LA459
Date & Time:	07/02/2011, 2040 EDT	**Registration:**	N330JK
Aircraft:	WINGTIP TO WINGTIP, LLC PANZL S-330	**Aircraft Damage:**	Substantial
Defining Event:	Part(s) separation from AC	**Injuries:**	1 None
Flight Conducted Under:	Part 91: General Aviation - Air Race/Show		

Analysis

The entire left aileron separated from the airplane as the pilot was performing an aerobatic aileron-roll maneuver during an airshow aerobatic demonstration flight. The pilot was able to recover into level flight and make an uneventful landing. The pilot stated that his preflight inspection before the accident flight did not reveal any mechanical issues with the airplane, including loose jam nuts or any other aileron anomalies. However, the pilot reported that his aviation mechanic had to retighten the jam nut for the center aileron hinge rod-end after it had been found loose on several occasions before the accident flight.

A postaccident examination revealed that the center aileron hinge had failed in the shank region of the rod end due to reverse bending fatigue. No material issues were identified with the center aileron rod end, which met the part specifications. A design analysis confirmed that the aileron rod ends were adequate for the limit loads on the structure but were inadequate for fatigue tolerance. The stress levels in the rod end shank were at or above the endurance limit for the specified rod end material, regardless of a loose or tight jam nut. However, a loose jam nut further increased the stress in the rod end about 28 percent and would have reduced the cycles to a fatigue failure. Following the accident, the airplane manufacturer redesigned the aileron bracket assemblies by increasing the diameter of the rod end shank and reducing the moment arm between the bearing and the aileron bracket. The redesign yielded a total stress reduction of about 83 percent in the rod end, which was significantly below the endurance limit for the specified material.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The inadequate aileron hinge design, which resulted in the in-flight separation of the left

aileron following a fatigue failure of the center hinge rod-end.

Findings

Aircraft	Aileron control system - Design (Cause)
	Aileron control system - Fatigue/wear/corrosion (Cause)
	Aileron control system - Failure (Cause)

Factual Information

On July 2, 2011, at 2040 eastern daylight time, a Wingtip to Wingtip, LLC model Panzl S-330 airplane, N330JK, was substantially damaged when the entire left aileron separated from the airplane during an aerobatic flight over W K Kellogg Airport (BTL), Battle Creek, Michigan. The pilot, who was not injured, was able to land the airplane without further issue. The experimental airplane was registered to and operated by John Klatt Airshows, Inc., under the provisions of 14 Code of Federal Regulations Part 91, without a flight plan. Day visual meteorological conditions prevailed for the local airshow demonstration flight that departed at 2035.

The pilot reported that the left aileron departed the airplane as he was performing an aerobatic aileron-roll maneuver about 50 feet above the ground at 160 miles per hour with a 30-degree nose-up attitude. The pilot was able to recover into level flight and make an uneventful landing. The pilot reported that his aviation mechanic had to retighten the jam nut for the center aileron hinge rod-end after it had been found loose on several occasions before the accident flight. The pilot stated that his preflight inspection before the accident flight did not reveal any mechanical issues with the airplane, including loose jam nuts or any other aileron anomalies.

The left aileron was recovered in three major sections and was sent to the NTSB Materials Laboratory for additional examination. The examination revealed that the center aileron hinge had failed in the shank region of the rod end due to reverse bending fatigue that covered about 90-percent of the fracture face. The remaining 10-percent of the fracture face exhibited overstress signatures. The fatigue zones were located on the upper and lower portions of the fracture face as installed, indicating that the predominant loading was due to the actuation of the aileron. No material issues were identified with the center aileron rod end, which met the specification for a FAFNIR USA part number RE3ML6-2N. The rod end was constructed of AISI 8620 steel that had a specified tensile strength of 90 ksi. The remaining inboard and outboard aileron hinges exhibited fracture features consistent with overstress. The examination did not reveal any material anomalies with the inboard or outboard hinge assemblies.

The center rod end was installed in a 2024-T3 aluminum bracket that was attached to the wing rear spar. The rod end was threaded into the end of the bracket utilizing Loctite on the threads and a jam nut that was seated against the bracket to prevent the rod end from backing out. The accident airplane reportedly had experienced a loose jam nut on several flights before the accident. The rod end failed in the area of the shank adjacent to the aft edge of the bracket beneath the area where the jam nut normally was secured. A Finite Element Analysis (FEA) was performed on the design with a loose jam nut and a tight jam nut. The analysis indicated a maximum tensile stress of about 60 ksi at the upper surface of the shank for the loose jam nut

condition and about 47.5 ksi for the tightened jam nut. The fore-aft location of the maximum stress was at the shank-to-bracket interface for the loose jam nut condition and at the shank to jam nut interface for the tight jam nut condition.

Considering a typical airplane operating weight of 1,600 pounds and the design load factor of 10 G, the total aileron load was about 681 pounds due primarily to the bending stress produced by the vertical load at the bearing. The calculated load on the center hinge was about 286 pounds. The maximum bending stress was about 51.0 ksi and 65.7 ksi for the tight jam nut and loose jam nut conditions, respectively. The maximum bending stress occurred at the upper surface of the shank for the aileron deflected full trailing edge up. The total tensile stress at the upper edge of the shank was 52.4 ksi and 67.1 ksi for the tight jam nut and loose jam nut conditions, respectively. The loose jam nut condition yielded a 28-percent increase in the tensile stress versus the tight jam nut condition.

For steel components with a tensile strength less than 160 ksi, the endurance limit is expected to be about 50-percent of the tensile strength for smooth polished specimens. Based on the load estimates, the stress in the rod end was at or above the corresponding endurance limit.

Following the accident, the airplane manufacturer redesigned the aileron bracket assemblies by increasing the diameter of the rod end shank and reducing the moment arm between the bearing and the aileron bracket. The redesign yielded a total stress reduction of about 83-percent in the rod end, which was significantly below the endurance limit for the specified material.

History of Flight

Maneuvering-aerobatics	Part(s) separation from AC (Defining event)

Pilot Information

Certificate:	Airline Transport	**Age:**	44
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Single
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without Waivers/Limitations	**Last Medical Exam:**	03/03/2011
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	10/08/2009
Flight Time:	(Estimated) 13000 hours (Total, all aircraft), 180 hours (Total, this make and model), 10000 hours (Pilot In Command, all aircraft), 100 hours (Last 90 days, all aircraft), 50 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	WINGTIP TO WINGTIP, LLC	**Registration:**	N330JK
Model/Series:	PANZL S-330	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Experimental	**Serial Number:**	009
Landing Gear Type:	Tailwheel	**Seats:**	1
Date/Type of Last Inspection:	04/20/2011, Conditional	**Certified Max Gross Wt.:**	1900 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	180 Hours	**Engine Manufacturer:**	Lycoming
ELT:	Not installed	**Engine Model/Series:**	AEIO-540-EXP
Registered Owner:	John Klatt Airshows, Inc.	**Rated Power:**	300 hp
Operator:	John Klatt Airshows, Inc.	**Air Carrier Operating Certificate:**	None

Meteorological Information and Flight Plan

Observation Facility, Elevation:	BTL, 952 ft msl	**Observation Time:**	2053 EDT
Distance from Accident Site:	0 Nautical Miles	**Condition of Light:**	Dusk
Direction from Accident Site:		**Conditions at Accident Site:**	Visual Conditions
Lowest Cloud Condition:		**Temperature/Dew Point:**	26°C / 21°C
Lowest Ceiling:	Overcast / 3500 ft agl	**Visibility**	8 Miles
Wind Speed/Gusts, Direction:	8 knots, 260°	**Visibility (RVR):**	
Altimeter Setting:	29.98 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Battle Creek, MI (BTL)	**Type of Flight Plan Filed:**	None
Destination:	Battle Creek, MI (BTL)	**Type of Clearance:**	VFR
Departure Time:	2035 EDT	**Type of Airspace:**	Class C

Airport Information

Airport:	W K Kellogg Airport (BTL)	**Runway Surface Type:**	Asphalt
Airport Elevation:	952 ft	**Runway Surface Condition:**	Dry
Runway Used:	23R	**IFR Approach:**	None
Runway Length/Width:	10004 ft / 150 ft	**VFR Approach/Landing:**	Precautionary Landing

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 None		

Administrative Information

Investigator In Charge (IIC):	Andrew T Fox	**Adopted Date:**	12/05/2013
Additional Participating Persons:	Ralph J Payne; Federal Aviation Administration, Grand Rapids FSDO; Grand Rapids, MI		
Publish Date:	12/05/2013		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=81032		

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