AIRCRAFT INCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/3/2/1240
Aircraft Registration	**ZS-ARI**	**Date of Incident**	6 January 2019	**Time of Incident**	0523Z
Type of Aircraft	Cirrus SR22T			**Type of Operation**	Private Part 91
Pilot-in-command Licence Type	Private Pilot Licence	**Age**	74	**Licence Valid**	Yes
Pilot-in-command Flying Experience	Total Flying Hours	1585		Hours on Type	700
Last point of Departure	Lanseria Aerodrome (FALA), Gauteng Province				
Next Point of Intended Landing	Lanseria Aerodrome (FALA), Gauteng Province				
Location of the incident site with reference to easily defined geographical points (GPS readings if possible)					
Lanseria International Aerodrome (FALA) Runway 07, S25°56.6.64' E 027°55.30'					
Meteorological Information	Wind:100/03KT; Visibility: CAVOK; Temperature: 19°C; Dew point: 14°C: QNH: 1020				
Number of People On-board	1 + 1	**No. of People Injured**	0	**No. of People Killed**	0
Synopsis					

The aircraft took off from Lanseria International Aerodrome (FALA) on Runway (RWY) 07 at 0520Z with a pilot and a passenger on-board for exercises within the circuit in relation to the private pilot licence (PPL) renewal. The first circuit was completed without any event, however, in the second circuit during landing whilst the the aircraft was on a ground roll, the nose gear collapsed.

The propeller struck the ground and the aircraft skidded 30 metres (m) before coming to a stop. The pilot and the passenger were not injured; they disembarked the aircraft unassisted. The aircraft sustained damage to the nose gear, propeller and engine cowling. The aircraft was towed to the hangar after the incident.

The investigation revealed that the nose landing gear (NLG) strut assembly collapsed during the landing roll as a result of a fractured strut tube adjacent to the forward edge of the gusset tube attachment welds. It is probable that the cause of the fracture was a result of an undetected fatigue crack.

SRP Date	11 October 2019	Publication Date	17 October 2019

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ABBREVIATION	DESCRIPTION
AD	Airworthiness Directive
AIID	Accident and Incident Investigation Division
AMO	Aircraft Maintenance Organisation
AMSL	Above Mean Sea Level
CAVOK	Ceiling and Visibility OK
CVR	Cockpit Voice Recorder
FALA	Lanseria International Airport
FDR	Flight Data Recorder
ft	Feet
GPS	Global Positioning System
KT	Knot
m	Metre
MHz	Megahertz
MPI	Mandatory Periodic Inspection
NDT	Nonn-destructive Testing
NLG	Nose Landing Gear
NM	Nautical Mile
NTSB	National Transportation Safety Board
PPL	Private Pilot Licence
SACAA	South African Civil Aviation Authority
SAWS	South African Weather Service
SB	Service Bulletin
RNW	Runway
TBO	Time Between Overhaul
USA	United States of America
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions

Reference Number	**:** CA18/3/2/1240
Name of Owner/Operator	**:** DR LJ Levien
Manufacturer	**:** Cirrus Design Corporation
Model	**:** Cirrus SR22T
Nationality	**:** South African
Registration Marks	**:** ZS-ARI
Place	**:** Lanseria Airport (FALA), Gauteng Province
Date	**:** 6 January 2019
Time	**:** 0523Z

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to apportion blame or liability****.*

Investigations process:

The incident was notified to the Accident and Incident Investigations Division (AIID) on 6 January 2019 at about 0543Z. The Investigator/s went to Lanseria on 8 January 2019. The Investigator/s co-ordinated with all authorities on site by initiating the accident investigation process according to CAR Part 12 and investigation procedures. The AIID of the South African Civil Aviation Authority (SACAA) is leading the investigation as the Republic of South Africa is the State of Occurrence.

Notes:
1. Whenever the following words are mentioned in this Report, they shall mean the following:

- *Incident — this investigated Incident*
- *Aircraft — the Cirrus SR22T involved in this incident*
- *Investigation — the investigation into the circumstances of this incident*
- *Pilot — the pilot involved in this incident*
- *Report — this incident Report*

2. Photos and figures used in this report are taken from different sources and may be adjusted from the original for the sole purpose of improving the clarity of the report. Modifications to images used in this report are limited to cropping, magnification, file compression or enhancement of colour, brightness, contrast or addition of text boxes, arrows or lines.

Disclaimer:

This report is produced without prejudice to the rights of the South African Civil Aviation Authority (SACAA), which are reserved.

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 A pilot and a passenger took off at 0520Z from Runway (RWY) 07 at Lanseria International Aerodrome (FALA) for exercises within the circuit in relation to the private pilot licence (PPL) renewal.

1.1.2 The aircraft completed the first circuit and made a visual approach for landing on RWY07.

1.1.3 At 0523Z, the aircraft landed on RWY07 and, during the landing roll, the nose gear collapsed; the propeller struck the runway surface and the aircraft skidded 30 metres (m) before coming to a stop.

1.1.4 The pilot and the passenger were not injured during the incident; they disembarked the aircraft unassisted. The aircraft sustained damage to the nose gear, propeller and engine cowling.

1.1.5 The flight was conducted in visual meteorological conditions (VMC) by daylight. The incident occurred on RWY07 at FALA and at Global Positioning System (GPS) co-ordinates determined as: S25°56.6.64’ E 027°55.30’ at an elevation of 5110 feet (ft) above mean sea level (AMSL).

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	1	-	1	-

1.3 Damage to Aircraft

1.3.1 The aircraft sustained minor damage.

Figure 1: The damaged aircraft.

1.4 Other Damage

1.4.1 None.

1.5 Personnel Information

Nationality	South African	Gender	Male	Age	74
Licence Number	************	Licence Type	Private Pilot Licence		
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Night, Instrument and Safety Pilot				
Medical Expiry Date	30 May 2019				
Restrictions	Corrective lenses				
Previous Accidents	None				

Flying Experience:

Total Hours	1585
Total Past 90 Days	8
Total on Type Past 90 Days	8
Total on Type	700

1.6 Aircraft Information

Airframe:

Type	Cirrus SR22T	
Serial Number	0808	
Manufacturer	Cirrus Design Corporation	
Date of Manufacture	2014	
Total Airframe Hours (At time of Accident)	348.6	
Last MPI (Date & Hours)	19 September 2018	335.1
Hours since Last MPI	13.5	
C of A (Issue Date)	8 October 2014	
C of R (Issue Date) (Present owner)	13 November 2017	
Operating Categories	Private Part 91	

1.6.1 Following a spate of similar occurances, the manufacturer had issued several service bulletins (SBs) to inspect the nose gear for cracks. The SB2X-32-22R2 was issued on 12 April 2016 and revised on 5 January 2018. The SB required that if the cracks are identified in metal on or around the surface of fillet welds, the aircraft is prohibited from flight until the nose landing gear strut assembly is replaced. According to the reviewed records during the investigations, the aircraft maintenance organisation (AMO) had complied with all necessary SBs and no cracks were identified prior to the incident flight. The SB was complied with on 19 September 2018 at 335.1 airframe hours. The aircraft had been operated for 13.5 hours since the SB was complied with.

Engine:

Type	Continental TSIO-550-K
Serial Number	1010314
Hours since New	348.6
Hours since Overhaul	TBO not reached

Propeller:

Type	Hartzell
Serial Number	PHC-J3Y1F-1N
Hours since New	348.6
Hours since Overhaul	TBO not reached

1.7 Meteorological Information

1.7.1 The weather information for FALA on 6 January 2019 at 0500Z was sourced from the South African Weather Service (SAWS).

Wind direction	100	Wind speed	03KT	Visibility	CAVOK
Temperature	19°C	Cloud cover	Nil	Cloud base	Nil
Dew point	14°C	QNH	1020		

1.8. Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACAA) for the aircraft type. There were no defects reported with the navigational equipment prior to the flight.

1.9 Communication

1.9.1 The aircraft was equipped with standard communication equipment that meets the requirements of the Regulator. There were no reported defects with the communication equipment at the time of the accident. The pilot was in contact with FALA tower on frequency 124.00 Megahertz (MHz).

1.10 Aerodrome Information

1.10.1 FALA RWY07 is 9951 X 98 feet (ft).

Aerodrome Location	Lanseria Aerodrome (FALA)
Aerodrome Co-ordinates	25°5623’23.0”S 027°55’28.8”E
Aerodrome Elevation	4517ft AMSL
Runway Used	07
Runway Dimensions	9951 X 98 feet
Runway Surface	Asphalt
Approach Facilities	DVOR, UHF DME, ILS/VOR/MLS, MAG VAR

1.11 Flight Recorders

1.11.1 The aircraft was neither equipped with a flight data recorder (FDR) nor a cockpit voice recorder (CVR), nor was it required by the relevant aviation regulation to be fitted in this aircraft type.

1.12 Wreckage and Impact Information

1.12.1 The aircraft landed on RWY07 at 0523Z. The aircraft's nose gear had collapsed during the landing roll; the propeller struck the runway surface and the aircraft skidded 30m before coming to a stop. The aircraft had remained on the runway centre line throughout the sequence of events. On site examination revealed that the nose gear collapsed, and the propeller blades struck the runway. The nose gear strut tube had failed below the gusset tubes welds (see Figures 3 and 4).

1.12.2 The nose landing gear consists of a main strut tube and two gusset tubes near the top portion of the main strut tube.

Figure 2: Damage sustained on the nose wheel.

Figures 3 and 4: A failed strut tube (right) and a normal strut tube (left).

1.13 Medical and Pathological Information

1.13.1 None.

1.14 Fire

1.14.1 There was no evidence of pre- or post-impact fire.

1.15 Survival Aspects

1.15.1 The accident was considered survivable due to the cabin or cockpit area having no damage which could have caused injuries to the pilot and/or passenger.

1.16 Tests and Research

1.16.1 The National Transportation Safety Board (NTSB) had 12 similar cases out of 6526 aircraft accidents between 2001 and 2018 that were reported. The Cirrus SR22T is prone to nose gear shimmy which leads to metal fatigue over time. The manufacturer also issued a Service Advisory Letter, SA 16-03 dated 7 March 2016 which warned of cracks developing on the nose landing gear strut assembly, close to the right- and left-hand welds of the gusset tubes. See Appendix 3.

1.16.2 The NTSB investigated and released two accident reports which occurred in the United States of America (USA) and Japan. The circumstances of the two accidents with regard to the failed/cracked components were similar to the failed/cracked components on ZS-ARI (see Figure 5 to 8). The comments made by the manufacturer as sited in the Japanese reports indicated the following actions to be taken (see Appendix 3):

Conclusion

1. Design Change

The Company will examine and increase the thickness around the welded part of the strut tube of the nose landing gear in order to improve the strut strength of the welded part.

2. Inspection

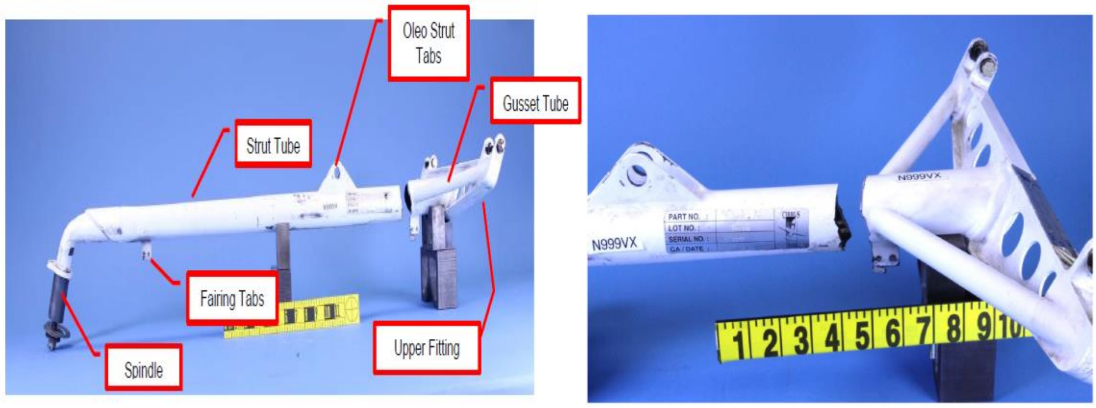
The Company plans to incorporate the special inspection after an occurrence of a shimmy (the contents is the same as the above-mentioned maintenance instruction) into the maintenance procedures.

1.16.3 The Japanese report identified the cause of the failure/crack as (see Appendix 4):

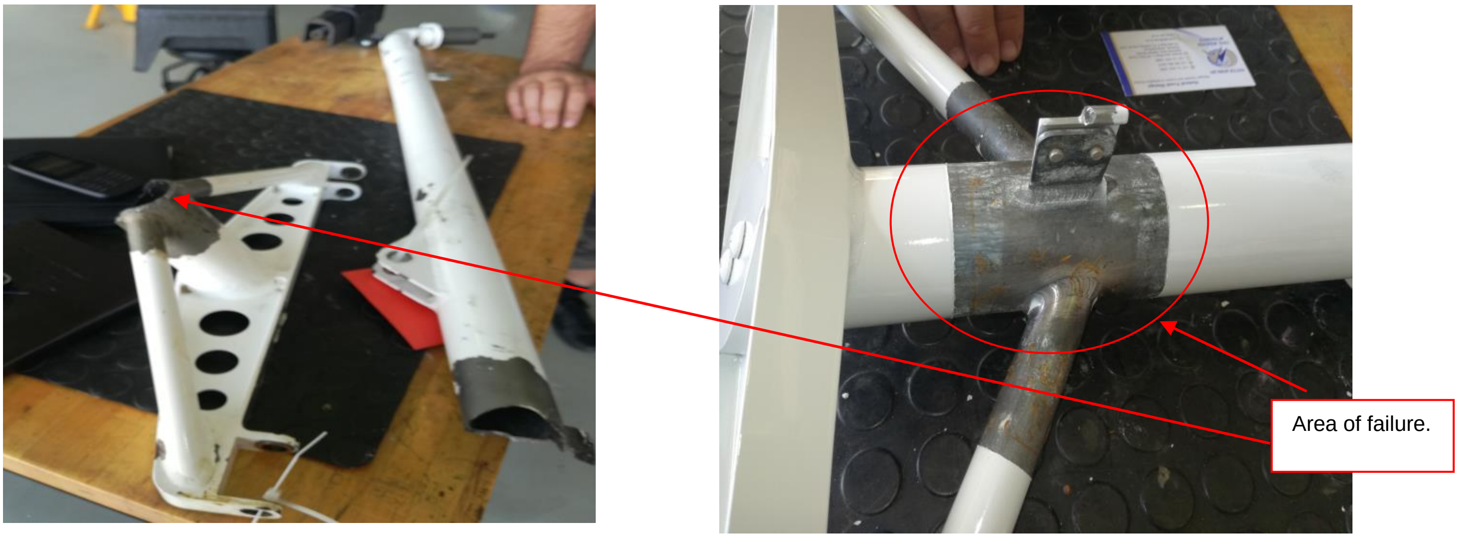
Regarding the fracture of the nose landing gear strut tube, it is probable that because undetected fatigue crack which had been generated at the forward toe of the Gusset tube weld bead of the strut tube prior to the occurrence of the serious incident progressed and the strength of the nose landing gear strut tube was decreased significantly, the load which was applied on the nose landing gear at landing of this serious incident resulted in the fracture.

Regarding the initiation and progression of the fatigue crack at the forward of the Gusset tube weld bead of the strut tube, it is somewhat likely that the repeated occurrences of the shimmy at landing of the Aircraft had contributed.

1.16.4 The USA report concluded that the cause of failure/crack was due to an unanticipated fatigue load. See Appendix 3.



Figures 5 and 6: Investigated failed strut tubes by NTSB.



Figures 7 and 8: A failed strut tube (left) and a normal strut tube (right).

1.17 Organisational and Management Information

1.17.1 The aircraft was operated as a private flight under the provision of the Civil Aviation Regulation (CAR) 2011, Part 91.

1.17.2 The AMO responsible for the maintenance of this aircraft was AMO 1099 and was issued with an approval on 1 August 2018, expiring on 31 July 2020.

1.17.3 The aircraft manufacturer issued several SBs (first SB in 2009 and the latest in 2018) which called for visual inspection of the area of the nose gear strut where the two gusset tubes are connected. See Attachment A to D.

1.17.4 The SB was complied with on 19 September 2018 at 335.1. The aircraft had been operated 13.5 hours since the SB was complied with.

1.18 Additional Information

1.18.1 None.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 General

The following analysis was made with respect to this incident. These shall not be read as apportioning blame or liability to any particular organisation or individual.

2.2 Analysis

2.2.1 The pilot was issued with a private pilot licence (PPL) on 20 June 2018 with the required rating to operate the aircraft which would expire on 30 June 2020. The pilot had completed his validation on 6 June 2018. The pilot had a total of 1585 flying hours of which 700 hours were on type and 8.0 hours were accumulated in the last 90 days. His medical certificate was issued on 13 June 2018 with an expiry date of 30 May 2019 and restrictions to wear corrective lenses.

2.2.2 The last annual inspection was carried out on 19 September 2018 at 335.1 and the aircraft had flown 13.5 hours since the last annual inspection was performed. Although the aircraft was signed out as serviceable and flew 13.5 hours prior to the incident, it is probable that the SB2X-32-22R2 was not correctly carried out.

2.2.3 The NTSB had conducted a metallurgy analysis on the failed nose gear strut on two other incidents which occurred in the USA and Japan, respectively. The circumstances of the two incidents with regards to the failed components were similar to the failed components on ZS-ARI. The reports concluded that the cause of the NLG strut fracture was a fatigue crack which originated in the area below the weld of the gusset attachment point.

2.2.4 The manufacturer had, between 2009 and 2018, issued several SBs with a service letter in 2014 calling for the visual inspection of the NLG strut at the area of the attachment of the two gusset tubes. Several occurrences pertaining to the NLG failure or collapse have been recorded worldwide between 2001 and 2018. The manufacturer's interventions to introduce the 50-hour inspection and to increase the NLG strut thickness were found to be inadequate to mitigate failure of the NLG strut.

2.2.5 The weather at the time of the accident was visual meteorological conditions (VMC) with no reports of any significant conditions that may have adversely affected the operation of the aircraft. Visibility was ceiling and visibility OK (CAVOK) and the surface wind was 220° at 5-10 knots.

2.2.6 The investigation revealed that the nose landing gear (NLG) strut assembly collapsed during the landing roll as a result of a fractured strut tube adjacent to the forward edge of the gusset tube attachment welds. It is probable that the cause of the fracture was as a result of an undetected fatigue crack.

3. CONCLUSION

3.1 General

The following findings, causes and contributing factors were made with respect to this incident. These shall not be read as apportioning blame or liability to any particular organisation or individual.

To serve the objective of this Investigation, the following sections are included in the conclusions heading:

- **Findings —** are statements of all significant conditions, events or circumstances in this Incident. The findings are significant steps in this incident sequence but they are not always causal or indicate deficiencies.
- **Causes —** are actions, omissions, events, conditions, or a combination thereof, which led to this Incident.
- **Contributing factors —** are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the Incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

3.2 Findings

3.2.1 The pilot was issued with a private pilot licence on 20 June 2018 with an expiry date of 30 June 2020. His last skills test was conducted on 6 June 2018. The pilot was issued with a medical certificate on 13 June 2018 with an expiry date of 30 May 2019.

3.2.2 The aircraft was issued a certificate of registration on 13 November 2017.

3.2.3 The certificate of airworthiness was issued on 8 October 2014 with an expiry date of 7 October 2019.

3.2.4 The last maintenance mandatory periodic inspection (MPI) was conducted on 19 September 2018 at 335.1 hours. The SB was signed out on 19 September 2018 at 335.1. The aircraft had been operated 13.5 hours since the last maintenance. Although the aircraft was signed out as serviceable and had been operated 13.5 hours prior to the incident, it is probable that the SB2X-32-22R2 was not correctly undertaken.

3.2.5 The pilot and the passenger were not injured during the incident sequence.

3.2.6 The Lanseria fire services responded to the scene and the aircraft was recovered to the hangar. The flight was conducted in visual meteorological conditions (VMC) by day.

3.2.7 The manufacturer had, between 2009 and 2018, issued several SBs with a service letter in 2014 calling for the visual inspection of the NLG strut at the area of the attachment of the two gusset tubes. Several occurrences pertaining to the NLG failure or collapse have been recorded worldwide between 2001 and 2018. The manufacturer's interventions to introduce the 50-hour inspection and to increase the NLG strut thickness were found to be inadequate to mitigate the failure/crack of the NLG strut.

3.2.8 The NTSB conducted a metallurgy analysis on the failed/cracked nose gear strut on the two incidents which occurred in the USA and Japan. The circumstances of the two incidents with regards to the failed/cracked components were similar to the failed component on ZS-ARI. The reports concluded that the cause of the NLG strut fracture was a result of a fatigue crack which originated at the area below the weld of the gusset attachment point.

3.2.9 The investigation revealed that the nose landing gear (NLG) strut assembly collapsed during the landing roll due to a fractured strut tube adjacent to the forward edge of the gusset tube attachment welds. It is probable that the cause of the fracture was a result of an undetected fatigue crack.

3.3 Probable Cause/s

3.3.1 The nose landing gear (NLG) strut assembly collapsed during the landing roll as a result of a fractured strut tube adjacent to the forward edge of the gusset tube attachment welds. It is probable that the cause of the fracture was a result of an undetected fatigue crack.

4. SAFETY RECOMMENDATIONS

4.1 General

The safety recommendations listed in this report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation, and are based on the conclusions listed in heading 3 of this report; the AIID expects that all safety issues identified by the investigation are addressed by the receiving States and organisations.

4.2 Safety Recommendation/s

4.2.1 The manufacturer to review SB number SB2X-32-22R2 to include a requirement for a non-destructive testing (NDT) inspection of the NLG strut tube for cracks.

4.2.2 The Director of Civil Aviation to consider issuing an Airworthiness Directive (AD) to all aircraft type Cirrus SR22T to conduct NDT inspection on the NLG strut assembly at their next 100-hour inspection and thereafter at a reasonal repeated interval until such time the manufacturer consider necessary actions to prevent future failures of Nose landing gear.

5. APPENDICES

5.1 Appendix 1: SB 2X-32-19
5.2 Appendix 2: SB 2X-32-19 R1
5.3 Appendix 3: NTSB Report
5.4 Appendix 4: Japan Report

Appendix 1

Number: **SB 2X-32-19**
Issued: July 29, 2009

SNS SUBJECT: 32-20 NOSE GEAR - Nose Landing Gear Assembly Inspection and Reinforcement

1. COMPLIANCE

Mandatory: Cirrus Design considers this Service Bulletin to be MANDATORY. Accomplish this Service Bulletin within the next 100 flight hours or within the next 12 calendar months. Compliance time begins upon receipt of this Service Bulletin.

Note: The information in this Service Bulletin will be incorporated into Inspection/Check - Nose Gear Assembly found in the SR22 Airplane Maintenance Manual by Temporary Revision 22AMM_TR_32-20-02 (Refer to AMM 32-20).

2. EFFECTIVITY

Cirrus Design SR22 Serials 0002 & subsequent.

3. APPROVAL

FAA approval has been obtained on all technical data in this Service Bulletin that affects type design.

4. PURPOSE

Some SR22 aircraft have developed cracks in the upper section of the nose landing gear (NLG). The cracks develop on the NLG assembly through the cross tube welds and gusset plate. To address this potential condition, a reoccurring inspection of the upper gusset plate, and forward surface of forward weld between the cross tube and strut is required.

If evidence of cracking is identified, it may be necessary to install hardware through the forward cross tube of the NLG assembly to strengthen load capabilities of the cross tube and prevent further cracking.

5. DESCRIPTION

This Service Bulletin contains instructions describing a reoccurring inspection to the NLG assembly for cracking, and, if necessary, installation of hardware through the forward cross tube of the NLG assembly.

6. WARRANTY INFORMATION

For aircraft under warranty at the issue date of this Service Bulletin, Cirrus Design will cover all parts and labor costs for this Service Bulletin if the work is accomplished within the Compliance time period and the work is performed at an authorized Cirrus Design Service Center.

7. MANPOWER REQUIREMENTS

Visual Inspection w/o surface protection removal and w/o dye penetrant: 0.5 man-hour.

Inspection w/ surface protection removal and w/ dye penetrant: 2.0 man-hours.

Kit hardware installation: 1.25 man-hours.

SR22 AMM Temporary Revision

32-20-02

Nose Gear

Inspection/Check - Nose Gear Assembly

Affected Manuals: SR22 Airplane Maintenance Manual (13773-001 RA3)

Serial Numbers: Serials 0002 and subsequent.

Filing Instructions: Insert this temporary revision adjacent to the Inspection/Check - Nose Gear Assembly procedure on page 10 and Figure 32-205 on page 22 of Chapter 32, Section 20 in the SR22 Airplane Maintenance Manual and retain until further notice.

This temporary revision supersedes 22AMM_TR_32-20-01.

Purpose: Add reoccurring inspection of the upper gusset plate on the NLG assembly, and repair instructions for hardware installation through the forward cross tube of the NLG assembly to strengthen load capabilities of the cross tube.

This temporary revision, dated 29 July 2009, adds, supersedes, or deletes information in the SR22 Airplane Maintenance Manual and is valid until further notice.

Pages that change due to this temporary revision are dated 29 July 2009 and changed content is marked with a revision bar.

FAA approval has been obtained on all technical data in these instructions that affects type design.

CIRRUS

SR22
Service Bulletin

Number: **SB 2X-32-19 R1**
Issued: July 29, 2009
Revised: September 03, 2009

SNS SUBJECT: 32-20 NOSE GEAR - Nose Landing Gear Assembly Inspection and Reinforcement

1. COMPLIANCE

Mandatory: Cirrus Design considers this Service Bulletin to be MANDATORY. Accomplish this Service Bulletin within the next 100 flight hours or within the next 12 calendar months. Compliance time begins upon receipt of this Service Bulletin.

This Service Bulletin was revised to provide alternate bolt part numbers and to change the warranty information. Operators who have successfully complied with the original release of this Service Bulletin, dated 29 Jul 2009, need take no further action.

Note: The information in this Service Bulletin will be incorporated into Inspection/Check - Nose Gear Assembly found in the SR22 Airplane Maintenance Manual by Temporary Revision 22AMM_TR_32-20-02 (Refer to AMM 32-20).

2. EFFECTIVITY

Cirrus Design SR22 Serials 0002 & subsequent.

3. APPROVAL

FAA approval has been obtained on all technical data in this Service Bulletin that affects type design.

4. PURPOSE

Some SR22 aircraft have developed cracks in the upper section of the nose landing gear (NLG). The cracks develop on the NLG assembly through the cross tube welds and gusset plate. To address this potential condition, a reoccurring inspection of the upper gusset plate, and forward surface of forward weld between the cross tube and strut is required.

If evidence of cracking is identified, it may be necessary to install hardware through the forward cross tube of the NLG assembly to strengthen load capabilities of the cross tube and prevent further cracking.

5. DESCRIPTION

This Service Bulletin contains instructions describing a reoccurring inspection to the NLG assembly for cracking, and, if necessary, installation of hardware through the forward cross tube of the NLG assembly.

6. WARRANTY INFORMATION

For aircraft under warranty at the issue date of this Service Bulletin, Cirrus Design will cover parts and labor costs for the Upper Gusset Plate Inspection and Approved Repair - Nose Landing Gear Reinforcement portions of this Service Bulletin if the work is accomplished within the Compliance time period and the work is performed at an authorized Cirrus Design Service Center, through the duration of the warranty period.

If opting not to install Approved Repair - Nose Landing Gear Reinforcement, the part and labor cost for the Forward Nose Gear Strut Fillet Weld Inspection portion of this Service Bulletin are at the owner's expense.

7. MANPOWER REQUIREMENTS

Visual Inspection w/o surface protection removal and w/o dye penetrant: 0.5 man-hour.

Visual Inspection w/ surface protection removal and w/ dye penetrant: 2.0 man-hours.

Kit hardware installation: 1.25 man-hours.

CIRRUS

SR22
Service Bulletin

Number: **SB 2X-32-19 R1**
Issued: July 29, 2009
Revised: September 03, 2009

SNS SUBJECT: 32-20 NOSE GEAR - Nose Landing Gear Assembly Inspection and Reinforcement

1. COMPLIANCE

Mandatory: Cirrus Design considers this Service Bulletin to be MANDATORY. Accomplish this Service Bulletin within the next 100 flight hours or within the next 12 calendar months. Compliance time begins upon receipt of this Service Bulletin.

This Service Bulletin was revised to provide alternate bolt part numbers and to change the warranty information. Operators who have successfully complied with the original release of this Service Bulletin, dated 29 Jul 2009, need take no further action.

Note: The information in this Service Bulletin will be incorporated into Inspection/Check - Nose Gear Assembly found in the SR22 Airplane Maintenance Manual by Temporary Revision 22AMM_TR_32-20-02 (Refer to AMM 32-20).

2. EFFECTIVITY

Cirrus Design SR22 Serials 0002 & subsequent.

3. APPROVAL

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4. PURPOSE

Some SR22 aircraft have developed cracks in the upper section of the nose landing gear (NLG). The cracks develop on the NLG assembly through the cross tube welds and gusset plate. To address this potential condition, a reoccurring inspection of the upper gusset plate, and forward surface of forward weld between the cross tube and strut is required.

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6. WARRANTY INFORMATION

For aircraft under warranty at the issue date of this Service Bulletin, Cirrus Design will cover parts and labor costs for the Upper Gusset Plate Inspection and Approved Repair - Nose Landing Gear Reinforcement portions of this Service Bulletin if the work is accomplished within the Compliance time period and the work is performed at an authorized Cirrus Design Service Center, through the duration of the warranty period.

If opting not to install Approved Repair - Nose Landing Gear Reinforcement, the part and labor cost for the Forward Nose Gear Strut Fillet Weld Inspection portion of this Service Bulletin are at the owner's expense.

EFFECTIVITY:
SR22 Serials 0002 & subs.

SB 2X-32-19 R1
Page 1

CIRRUS SERVICE BULLETIN MODEL SR22

7. MANPOWER REQUIREMENTS

Visual Inspection w/o surface protection removal and w/o dye penetrant: 0.5 man-hour.

Visual Inspection w/ surface protection removal and w/ dye penetrant: 2.0 man-hours.

Kit hardware installation: 1.25 man-hours.

National Transportation Safety Board
Aviation Incident Final Report

Location:	Paso Robles, CA	**Incident Number:**	WPR16IA025
Date & Time:	11/07/2015, 1234 PST	**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 (Cause)
	Nose/tail landing gear - Design
	Nose/tail landing gear - Capability exceeded (Cause)

AI2017-4

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

PRIVATELY OWNED
J A 0 1 Y K

August 31, 2017

JTSB Japan Transport Safety Board

DA :

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board (and with Annex 13 to the Convention on International Civil Aviation) is to prevent future accidents and incidents. It is not the purpose of the investigation to apportion blame or liability.

Kazuhiro Nakahashi
Chairman
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

PRIVATELY OWNED CIRRUS SR22T, JA01YK INABILITY TO OPERATE DUE TO DAMAGES OF THE LANDING GEAR OF THE AIRCRAFT KAGOSHIMA AIRPORT AT ABOUT 13:20 JST, MARCH 21, 2016

July 21, 2017

Adopted by the Japan Transport Safety Board

Chairman	Kazuhiro Nakahashi
Member	Toru Miyashita
Member	Toshiyuki Ishikawa
Member	Yuichi Marui
Member	Keiji Tanaka
Member	Miwa Nakanishi

SYNOPSIS

<Summary of the Serious Incident>

On Monday, March 21, 2016, a privately owned Cirrus SR22T, registered JA01YK, took off from Nagasaki Airport for the purpose of a familiarization flight, the strut assembly of the nose landing gear was fractured at landing on the runway 34 of Kagoshima Airport and the Aircraft stopped there as its nose in contract with the runway.

There were five people on board, consisting of a captain and four passengers, there were no injured.

The Aircraft sustained minor damages, but there was no outbreak of fire.

<Probable Causes>

It is certain that this serious incident occurred as the Aircraft was unable to taxi itself because the Aircraft had fractured its nose landing gear strut tube at landing and halted as leaning forward condition while the nose of the Aircraft was in contact with the runway.

Regarding the fracture of the nose landing gear strut tube, it is probable that because undetected fatigue crack which had been generated at the forward toe of the Gusset tube weld bead of the strut tube prior to the occurrence of the serious incident progressed and the strength of the nose landing gear strut tube was decreased significantly, the load which was applied on the nose landing gear at landing of this serious incident resulted in the fracture.

Regarding the initiation and progression of the fatigue crack at the forward of the Gusset tube weld bead of the strut tube, it is somewhat likely that the repeated occurrences of the shimmy at landing of the Aircraft had contributed.

In addition, it is probable that the repeated application of high tensile stress onto the left side of the forward of the Gusset tube weld bead of the strut tube had contributed to the progress of the crack, because the captain had operational tendencies to initiate the left turn at the speed which the Aircraft did not decelerate sufficiently in order to vacate the runway after landing.

The abbreviations used in this report are as follows:

ADL	: Aircraft Data Logger
ALT	: Altitude
AP	: Auto Pilot
DA	: Decision Altitude
DH	: Decision Height
FAA	: Federal Aviation Administration
GP	: Glide Path
GS	: Glide Slope
IAS	: Indicated Air Speed
IFR	: Instrument Flight Rules
KIAS	: Knot Indicated Air Speed
MDA	: Minimum Descent Altitude
NTSB	: National Transportation Safety Board
PAPI	: Precision Approach Path Indicator
PIT	: Pitch
SA	: Service Advisory
SB	: Service Bulletin
SD	: Secure Digital
TCA	: Terminal Control Area
VFR	: Visual Flight Rules
VS	: Vertical Speed
WPB	: Wheel Pant Bracket

Unit Conversion List:

1 kt	: 1.852 km/h
1 nm	: 1.852 km
1 ft	: 0.3048 m
1 lb	: 0.4536 kg
1 in	: 25.40 mm
1 G	: 9.806 m/s^2

1. PROCESS AND PROGRESS OF THE AIRCRAFT SERIOUS INCIDENT INVESTIGATION

1.1 Summary of the Serious Incident

On Monday, March 21, 2016, a privately owned Cirrus SR22T, registered JA01YK, took off from Nagasaki Airport for the purpose of a familiarization flight, the strut assembly of the nose landing gear was fractured at landing on the runway 34 of Kagoshima Airport and the Aircraft stopped there as its nose in contract with the runway.

There were five people on board, consisting of the captain and four passengers, there were no injured.

The Aircraft sustained minor damages, but there was no outbreak of fire.

1.2 Outline of the Serious Incident Investigation

The occurrence covered by this report falls under the category of "Case where any of aircraft landing gear is damaged and thus flight of the subject aircraft could not be continued" as stipulated in Clause 8, Article 166-4 of Ordinance for Enforcement of the Civil Aeronautics Regulations of Japan, and is classified as a serious incident.

1.2.1 Investigation Organization

On Monday, March 21, 2016, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and two investigators to investigate this serious incident.

1.2.2 Representative from the relevant states

An accredited representative of the United States of America, as the State of Design and Manufacture of the Aircraft involved in this serious incident, participated in the investigation.

1.2.3 Implementation of the Investigation

March 22 to 23, 2016	Airframe Examination, On-site Investigation and Interviews
April 5, 2016	Examination on the nose landing gear parts
May to Early July, 2016	Fracture Face Examination on Strut Assembly part of Nose Landing Gear (Executed at the Laboratory of National Transportation Safety Board (NTSB))

1.2.4 Comments from the Parties Relevant to the Cause of the Serious Incident

Comments were invited from parties relevant to the cause of the serious incident.

1.2.5 Comments from Relevant State

Comments on the draft report were invited from the relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight

A privately owned Cirrus SR22T, registered JA01YK (hereinafter referred to as "the Aircraft"), took off from Nagasaki Airport on Monday, March 21, 2016, at 12:46, the Captain sat in the left seat for a familiarization flight with four passengers on board and flew to Kagoshima Airport.

The outline of the flight plan was as follows;

Flight rules:	Visual flight rules
Departure aerodrome:	Nagasaki Airport
Estimated off-block time:	12:45
Cruising speed:	175 kt
Cruising altitude:	VFR
Route:	SIMAGO (Visual Reporting Point)
Destination Aerodrome:	Kagoshima Airport
Total elapsed time:	1 hour 00 minute
Purpose of flight:	Familiarization flight
Fuel load expressed in endurance:	3 hours 00 minute
Persons on board	5

History of the flight up to the time of the serious incident is summarized below, based on ATC Communications Records, Radar Tracking Records of Kagoshima Terminal Control Facility and the Records of Aircraft Data Logger (hereinafter referred to as "ADL" to be described in 2.7), as well as the statements from the captain and Air Traffic Controller (hereinafter referred to as "the Controller").

2.1.1 History of the Flight based on ATC Communications Records, Radar Tracking Records and the Records of ADL

13:11:00	The Aircraft made radio contact with the Aerodrome Control Tower in Kagoshima Airport (hereinafter referred to as "the Tower") to request a landing to Kagoshima Airport (hereinafter referred to as "the Airport").
13:11:31	The Tower instructed to fly over the west side of the departure course because there was a departure aircraft from the runway 34, and the Aircraft agreed to that.
13:12:23	Autopilot (AP) of the Aircraft was disengaged.
13:15:23	The Tower provided the traffic information of the departure aircraft and asked whether the Aircraft could confirm it by sight. The Aircraft reported "being looking for it".
13:15:43	The Aircraft reported back about confirming the departure aircraft by sight.
13:15:48	The Tower instructed to report at downwind leg.
13:16:05	The Aircraft reported to be at downwind leg and to be keeping the visual sighting of the departure aircraft.
13:16:08	The Tower instructed to extend downwind leg and report back when the Aircraft caught the sight of an arrival aircraft (E170) which located 3 nm on final approach course. The Aircraft read back.
13:16:36	The Aircraft reported to confirm the arrival aircraft by sight.
13:16:38	The Tower instructed to follow the arrival aircraft and caution wake turbulence, and the Aircraft read back.
13:18:20	The Aircraft started final approach at ground altitude 620 ft and IAS 110 kt.
13:18:26	The Tower added the traffic information of the preceding arrival aircraft in process of vacating the runway, issued landing clearance to the runway 34 and reported wind direction 200° and wind velocity 8 kt. The Aircraft read back.
13:19:22	The Aircraft touched down on the runway 34.
13:19:50	The Aircraft reported to have the nose landing gear collapsed and stranded. The Tower acknowledged and made an emergency call.

- 3 -

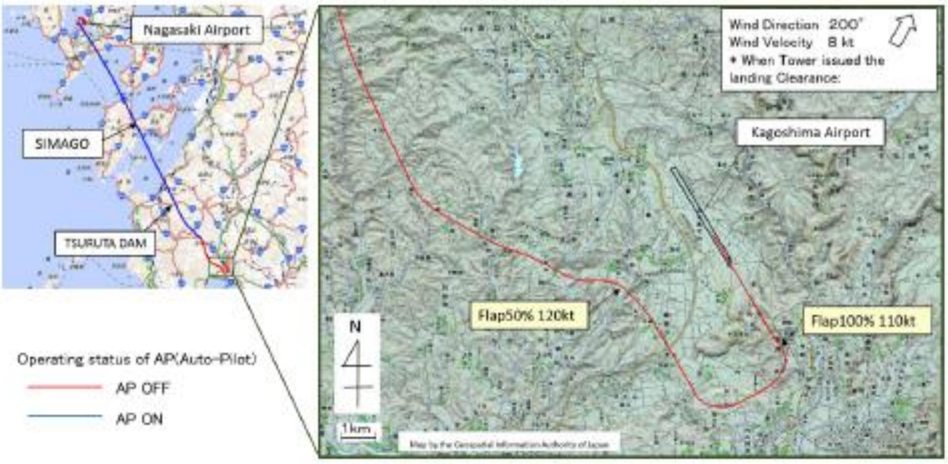

Figure 1 Estimated Flight Route

2.1.2 Statements of the Captain and the Controller

(1) The Captain

The captain conducted the pre-flight check at Nagasaki Airport and took off at 12:45 after confirming no abnormality on the Aircraft, VFR flying thorough about 3 nm east of Amakusa Airport at altitude about 5,500 ft, via TSURUTA DAM as the visual reporting point to Kagoshima Airport.

The Aircraft requested TCA Advisory*1 from Kagoshima Terminal Control Facility at about 25nm northwest of the Airport, and was instructed to contact with the Tower around TURUTA DAM. The Captain made radio contact with the Tower and was instructed to hold at 3 nm northwest of the Airport because of the departure aircraft. The departure aircraft already took off when the Aircraft came close to around 3 nm position, the Captain set the flap to 50 % and the airspeed at around 110 kt, reported the sighting of the departure aircraft to the Tower and entered into left downwind leg without holding.

When the Aircraft entered into left downwind leg, the Tower instructed to report back when sighting a twin-engine aircraft since it was on final approach, to extend downwind leg and to follow the preceding aircraft after reporting this sighting.

The Aircraft made a normal approach except for extending downwind leg. The status of the wind shown on the instrument of the Aircraft was tail wind

*1 "TCA Advisory" means services to provide radar traffic information and others for an aircraft flying VFR identified by radar within a terminal control area.

component of 6 kt and crosswind component of 3 kt. The wind was not enough to affect the maneuver, but because the Captain had impression that the Aircraft would fly rough when the wind blew from diagonally behind at the time of landing on the runway 34 of the Airport, he carried out the landing with care.

Received the landing clearance from the Tower, the Captain set flap down to 100 % right after the turning to final approach course and kept the airspeed at 90 kt for approach. The Captain thought that the aural speed warning message issued at slightly below 85 kt was unfavorable. This warning message is not the stall warning which shall be issued as warning at 78 kt of the stall speed of the Aircraft and this warning message is issued at 85 kt which is within the safety margin, but he approached with care not to activate this message. Furthermore, from the memory of instructor's instruction to keep 90 kt airspeed during flight training, the Captain was operating approach at the speed which would not activate this message.

The Captain touched down the main landing gear of the Aircraft first around the PAPI (Precision Approach Path Indicator). The Captain was wondering whether to vacate the runway via taxiway T2, but due to the situation requiring an application of hard brake, the Captain decided to vacate via the taxiway T3 without stepping on the pedals to brake.

The Captain had experienced the vibration of the nose landing gear of the Aircraft which was not strong as shimmy*2, and realized that the vibration could be controlled by pulling the control stick toward body enough to hold up the nose slightly and holding there by a little. The Captain did not felt much vibration at the touchdown, but as usual, he pulled the control stick once enough to hold the nose lightly after touchdown of the nose landing gear.

The Captain released the backpressure of the control stick to support the nose, and because the Aircraft was suddenly dropped down to lean forward at the point of the Aircraft passing the taxiway T2, the Captain recognized that the nose landing gear was collapsed. After halting the Aircraft, the Captain reported to the Tower that the Aircraft was stranded and then after turned off the switches for the power supply and other systems, got off from the Aircraft with the passengers.

(2) The Controller of the Tower

When the Aircraft entered into left downwind leg, because the preceding

*2 "Shimmy" is the short cycled oscillating vibration of the steering wheel (nose wheel or tail wheel) caused by the unbalance of the wheel or rough road surface.

arrival aircraft (aircraft flying IFR) was on final approach course, the Controller instructed to extend downwind leg and follow this arrival aircraft. The landing clearance was issued when the Aircraft was at around base leg, because the preceding aircraft had vacated the runway.

When the Aircraft was about to touchdown, the Controller did not see the touchdown of the Aircraft because the Controller was writing the arrival time of the Aircraft into the flight slip. At the next time for the Controller to look at the Aircraft, the Aircraft was on roll with the nose in contact with the runway.

The Captain reported that the Aircraft was stranded, a controller who left the Ground Control position to be replaced used Crash Phone to inform, after his shift ended.

The serious incident occurred at about 13:20 on March 21, 2016 on the runway of Kagoshima Airport (Latitude: 31°47'53" N, E130°43'23" E).

2.2 Injuries to Persons

No one was injured.

2.3 Damages to the Aircraft

2.3.1 Extent of Damage

Minor damage

2.3.2 Damage to the Aircraft Components

(1) Fuselage	: Damage at lower parts of Engine Cowling
(2) Propeller	: Blades (all three blades) damage
(3) Nose Landing Gear	: Fracture of the Strut tube

Photo 1 Propellers and its periphery

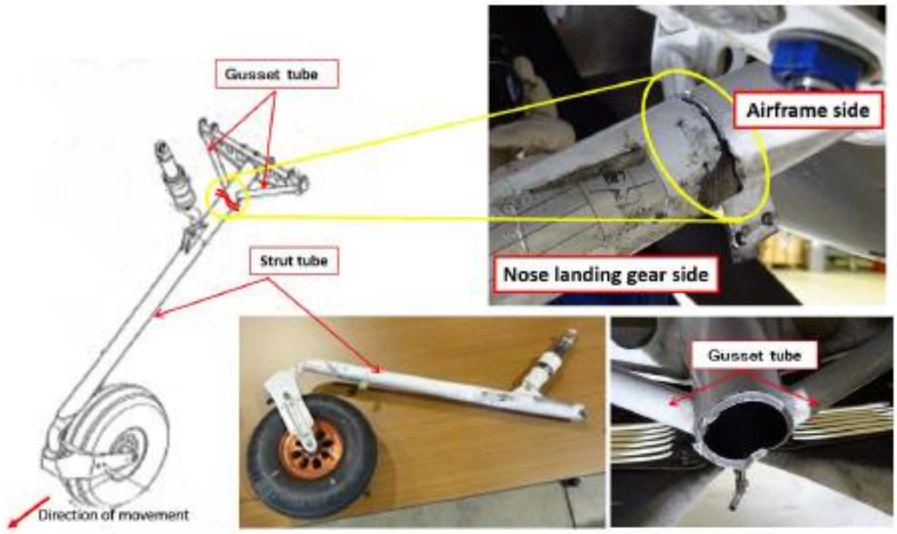

Figure 2 Nose landing gear and the Fractured Strut tube

2.4 Personnel Information

Captain	Male, Age 49
Private pilot certificate (Airplane)	June 21, 2010
Type rating for single engine (land)	
Specific Pilot Competence	
Expiration date of piloting capable period	August 11, 2016
Class 2 aviation medical certificate	
Validity	June 24, 2016
Total flight time	601 hours 21 minutes
Flight time in the last 30 days	17 hours 41 minutes
Total flight time on the type of aircraft	240 hours 14 minutes
Flight time in the last 30 days	17 hours 41 minutes

2.5 Aircraft Information

2.5.1 Aircraft

Type	: Cirrus SR22T
Serial Number	: 0920
Date of Manufacture	: December 2, 2014
Certificate of airworthiness	: No. To-27-173
Validity	: July 5, 2016

Category of airworthiness : Airplane, Normal N

Total flight time : 308 hours 50 minutes

Flight time since the last periodic check (100-hour check on February 10, 2016) : 19 hours 52 minutes

(See Appended Figure 1 Three Angle View of Cirrus SR22T)

2.5.2 Weight and Balance

At the time of the serious incident, it is estimated that the weight of the Aircraft was 3,397 lb and the position of the center of gravity was 144.8 in, and it is highly probable that both of them were within an allowable range (The Maximum take-off weight: 3,600 lb, Allowable range for the center of gravity corresponding to the weight of the Aircraft: 142.1 to 148.2 in).

2.6 Meteorological Information

Aerodrome special meteorological report (SPECI) of the Airport right after the serious incident was as followed:

13:24 Wind direction 200°; Wind velocity 7 kt;
Wind direction fluctuation 140° - 260°; Visibility 20 km
Cloud: Amount 2/8, Type Stratocumulus, Cloud base 5,000 ft
Amount 5/8, Type unknown, Cloud base unknown
Temperature 16°C; Dew point 2 °C
Altimeter setting (QNH) 30.08 inHg

2.7 Information on the Flight Recorder and others

The Aircraft was equipped with a device called ADL manufactured by Garmin Ltd. of United States of America, which automatically records both of an aircraft flight data and engine data. These flight data and others use SD memory card as its information medium, the recording duration differs depending on the capacity of a card. ADL of the Aircraft saved the records at the time of occurrence of the serious incident and other past flight data. (See Appended Figure 2 Records of ADL)

2.8 Information of the Serious Incident site

2.8.1 The Airport Information

The Airport is located at altitude 892 ft and has the runway which is 16/34 in direction, 3,000 m in length, and 45 m in width, and the overrun area at each end of the runway is 60 m in length.

2.8.2 Traces and other situation on the runway

(1) The Aircraft halted at 824 m inside of the runway 34 threshold.

(2) Dark and short-stroked contact traces which is matching width of tire (10 cm) of the nose wheel was at 571 m inside of the runway 34 threshold, but the tire marks of the main landing gear wheel could not be identified.

(3) Hiting marks by the propellers were left on the runway 34 from 609 m inside of the threshold for about 8 m intermittently. Furthermore, the scratch marks by the propellers were left from the 626 m inside of the runway 34 threshold to the Aircraft halt position.

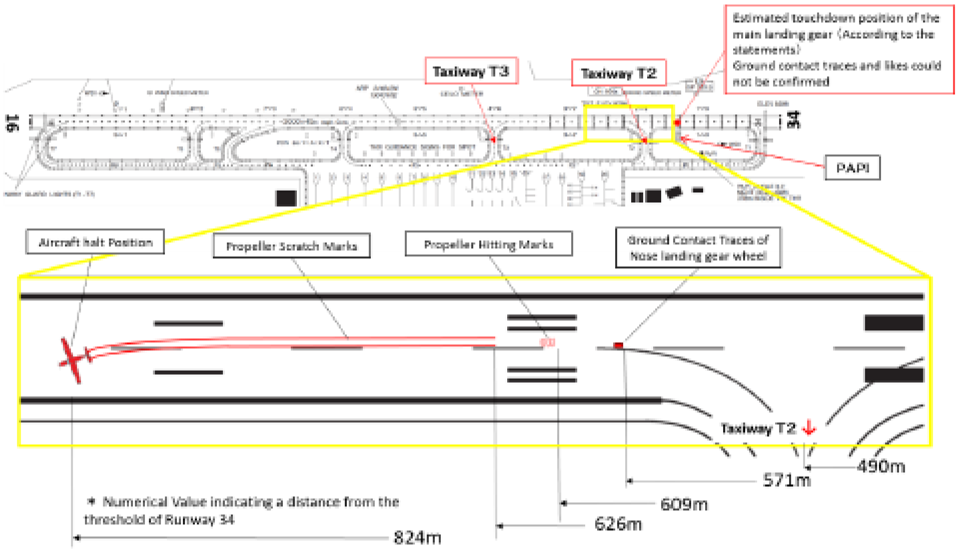

Figure 3 Traces on the runway

2.9 Fracture Surface Analysis, Load Test and likes of the Strut Assembly of the Nose Landing Gear

2.9.1 Fracture Surface Analyzed by National Transportation Safety Board (NTSB)

Fracture surface analysis of the nose landing gear strut tube concerning this incident was carried out at NTSB and the main results are as follows;

(1) The strut tube had a fatigue crack that generated prior to the occurrence of the serious incident.

(2) The left side of the fracture surface (the right side in Figure 4);

- 9 -

① The red broken lined parts indicates the progress of the crack which was generated at the forward toe of the Gusset tube weld bead of the strut tube(hereinafter referred to "the Edge of the strut tube") .

② The red arrow indicates the progress of the generated multiple cracks starting from the Edge of the strut tube.

③ The crack which penetrated the wall of the strut tube in the red broken lined parts indicates the occurrence of repeated stress in this part.

④ The yellow arrow indicates further progress of the penetrating crack to the top and bottom direction along the circumference of the strut tube and the advancement of the crack to the yellow broken line right before the fracture.

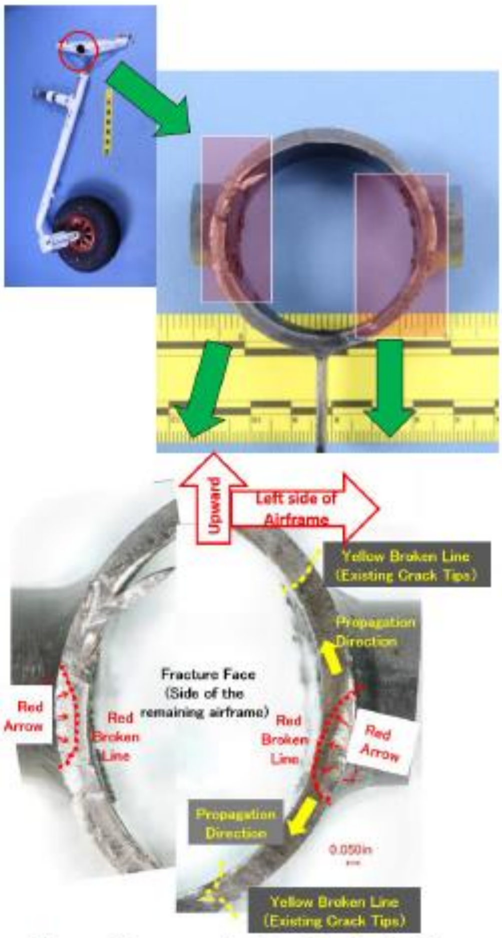

Figure 4 Fracture Surface Analysis of the nose landing gear strut tube

(3) The right side of the fracture surface (the left side in Figure 4);

As same as the left side of the fracture surface, the red broken line parts had the traces of the progressed crack starting from the multiple places at the Edge of the strut tube due to a fatigue. However, there was no penetration nor progress along the circumference direction due to cracks.

(4) The electron microscopic observations indicated the traces associated with repetition of the opening and closing of the crack on the fracture surface, and the welded part had even more small cracks at the Edge of the strut tube where the fatigue originated.

(5) A visual inspection on the welded surface of the fractured parts could not

determine the welding positions to start and to end, however, the front parts of welding was an appropriate working conditions.

(6) Both of dimensions and hardness of the strut tubes are just as specified by the airframe manufacturer (hereinafter referred to as "the Company").

2.9.2 Test carried out by the Company

After the serious incident, the Company carried out the analysis and verification tests on the nose landing gear of the same type of aircraft and the main test results are as follows;

(1) The crack occurred at the Edge of the strut tube and progressed to fracture the nose landing gear strut tube. This was results of the load of the lateral direction and not by the load due to the normal flight and landing.

(2) Additional Tests

① Load test for the nose landing gear strut tube

Running Static Load Test by a test case (applying load from a 90° direction) which generates a most strain on the strut tube wall, the strain started on the strut tube wall itself, however, the strain was without generating the crack at the Edge of strut tube.

By other test case (applying load from a 45° direction), the crack were generated at the mounting position of the Gusset tube to the airframe, but no crack generated at the end of the strut tube.

② Shimmy Test

Flying a side-slip using an actual aircraft up to touchdown and after the touchdown of the airplane, implementing the test as setting the nose landing gear lowered to ground as soon as possible, a shimmy was occurred. This shimmy could be mitigated by applying pitch up command via flight control system.

The results of the flight test showed the relatively light shimmy which could be attenuated soon after two cycles. This test measured the strain of the strut tube, but it was not enough to generate crack at the nose landing gear strut tube, however it was showing rather large strain. About this strain, it is expected that it could reach levels to generate cracks, if the shimmy were more severe or prolonged.

③ Inspection of the nose landing gear

The Company issued the Service Bulletin (SB2X-32-22 on April, 2016) which requested visual inspection using magnifying glass on the welded part between the nose landing gear strut tube and gusset tube to the user of the type of aircraft, but there are no report of crack generation as of November, 2016.

Furthermore, prior to this issuance of the Service Bulletin, because there were three reporting of the crack generation cases, as the Company carried out the detailed inspection, one of these cases was found to have the crack generated at the Edge of the strut tube of the both Gusset tubes.

(3) Conclusion

① Design Change

The Company will examine to increase the thickness around the welded part of the strut tube of the nose landing gear in order to improve the strut strength of the welded part.

② Inspection

The Company plans to incorporate the special inspection after an occurrence of a shimmy (the contents is the same as above mentioned maintenance instruction) into the maintenance procedures.

③ Pilot Training

The Company plans to incorporate a preventive measure for an occurrence of shimmy and, a countermeasure to take at the time of occurrence with the pilot training materials used at the Company.

2.10 Landing Operations

2.10.1 Flight Manual

The flight operation manual of the Aircraft includes the following descriptions (excerpts);

(1) Normal landing

Normal landing

1. Flaps .... 100 %
2. Airspeed .... 80 to 85 KIAS

Touchdown is operated at power-off, to touch at main wheels on the ground first, reduce the speed after landing and step on the brake pedals as required. After the speed of the airplane decrease, gently lower the nose wheel to touch on the ground.

(2) Autopilot Limitations

Minimum Autopilot Speed .... 80 KIAS

Minimum Autopilot –Use –Height

a. Take-off and Climb .... Ground altitude: 400 ft
b. En-route and descent .... Ground altitude: 1000 ft
c. Approach (GP or GS mode) .... Ground altitude: 200 ft or more, or the height exceeding the MDA, DA or DH which is specified in the approach procedures
d. Approach (IAS, VS, PIT or ALT mode) ....Ground altitude: 400 ft or more, or the height exceeding the MDA which is specified in the approach procedures

2.10.2 Pilot Textbook

"Airplane Operation Textbook" supervised by Civil Aviation Bureau (Japan Civil Aviation Promotion Foundation, March 31, 2009, the third version, p.98) includes the following descriptions regarding the landing procedure (Excerpts):

4.2.1 Normal Landing

(1) Final Approach

The most essential factors of a final approach is to keep a proper approach speed, to keep a proper approach angle and to align the Aircraft track with the centerline of the runway.

(2) Flare Maneuver

Pull up the pitch-up attitude in order to decrease a speed and descending rate and to obtain a lift, as approaching a runway. This flare maneuver is done to take a proper landing attitude and landing speed when an aircraft reaches the touchdown point.

(3) Touchdown

Ideal touchdown is for an aircraft to take a perfect landing attitude at the height about to touchdown at the speed close to the stall speed to touch the main landing gear on the ground.

(4) Landing Roll

After the nose landing gear touched down on the runway surface and if handling of inertia comes to be possible with brake, quietly and evenly step on the brake pedals to reduce the speed to the normal ground taxi speed. Do not hold the brake pedals down in attempt to deceleration.

2.11 Control and Maneuver by the Captain

2.11.1 Interview of the Standardized Instructor Pilot[*3] (hereinafter referred to as "the Instructor")

The contents of interview with the Instructor who was in charge of the training for the Captain from the start of introducing the Aircraft was as follows;

The Instructor had been training the Captain following the manual of the Company. The specification of the Aircraft at landing were flap-up at downwind leg, IAS 100 kt, 1,800 ft at the pressure altitude of the Airport to train, which is about 900 ft at the ground altitude. Then, operate at 50% flap and IAS 100 kt abeam touchdown point, maintain these and conduct a base turn. Set 100% flap and IAS 90 kt at a base leg, approach the final at IAS 80 kt, pass the runway threshold and continue at the speed which is little greater than the stall speed till touchdown. Squeeze the power slowly till touchdown, set power to idle at touchdown. The pitch angle of flare at touchdown about +5° to +7° because the pitch angle of the normal attitude of the Aircraft at ground is about +2° to +3°. The captain had a tendency to land with almost 3 points landing, but it was not within a dangerous range.

The stall warning of the Aircraft was sounded at about 10 kt plus the stall speed. It is not good that the stall warning is sounded during an approach, but if the warning is not sounded at touchdown, the touchdown speed is fast.

The ground taxi speed is the same as a regular aircraft, after a landing, about 10 to 15 kt for the speed to vacate a runway is appropriate. The Captain did sometime vacate the runway from the taxiway T2.

2.11.2 Records at the time of the serious incident occurrence (See Appended Figure 2 Records of ADL)

According to the records of ADL (see 2.7), the Aircraft was at the ground altitude of 620 ft and the airspeed of 110 kt at the time to complete the turning for the final approach. Then, as shown in Appended Figure 2, ① and ②, there were the fluctuation in pitch angle between about -10° and - 2° from the ground altitude of 400 kt and the fluctuation in an vertical acceleration[*4] between about – 0.5 G and + 0.3 G, which continued till near the runway threshold. After that, without big fluctuations in the pitch angle, the Aircraft touched down at approximately 340 m inside of the runway threshold.

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*3 "Standardized Instructor Pilot" is a person who holds a valid flight instructor certificate, received the training at the affiliated training facilities of the Company and was qualified as a training instructor for the type of an aircraft.

*4 "Vertical Acceleration"; the vertical acceleration recoded in ADL is presented as + or – based on 0 G (normally, 1 G)

The ground speed at the touchdown was 77 kt at ③ and the pitch angle at the same time was + 2.6° which was almost same as the parking attitude at ④. Later on, the pitch angle increased to + 4.6° at ⑤, decreased to + 3.7°, jumped up to + 6.6° as a maximum at ⑦, decreased again to +2.7° and rapidly decreased to - 18.4° at ⑨. At this time, the airspeed was 55 kt.

2.11.3 The records of the past flight

(1) Vacating the runway

According to the past flight records saved in ADL, the Aircraft vacated through the taxiway T2 for 29 times among 99 landing times on the runway 34 which the Captain landed on the runway 34 of the Airport. At the time, the touchdown point of the Aircraft was approximately 270 m in average from the runway threshold. The distance from the runway threshold to the centerline of the taxiway T2 is 490 m (See Figure 3).

Furthermore, the maximum ground speed at starting the left turn in order to vacate the runway through the taxiway T2 was 49 kt and the ground speed was rapidly decreased during the time to reach the taxiway T2.

The number of the landings made by the Captain at the Airport which the ground speed was exceeding 25 kt at the time to start the left turn in order to vacate the runway through whichever the taxiway was, were 71 times (among these, the landing with the speed exceeding 35 kt was 20 times) out of 99 times.

(2) Lateral Acceleration after the Touchdown

From the 29 times to vacate from the taxing T2 by the control of the Captain, the lateral acceleration after the touchdown was within the range of 0.14 G to 0.99 G. The variation of lateral acceleration and ground speed after the touchdown at the time to mark the 0.99 G for the lateral acceleration are as shown in Figure 5. Furthermore, including this case, the similar landing cases with wide swing of lateral acceleration to + and – were saved as in Table 1.

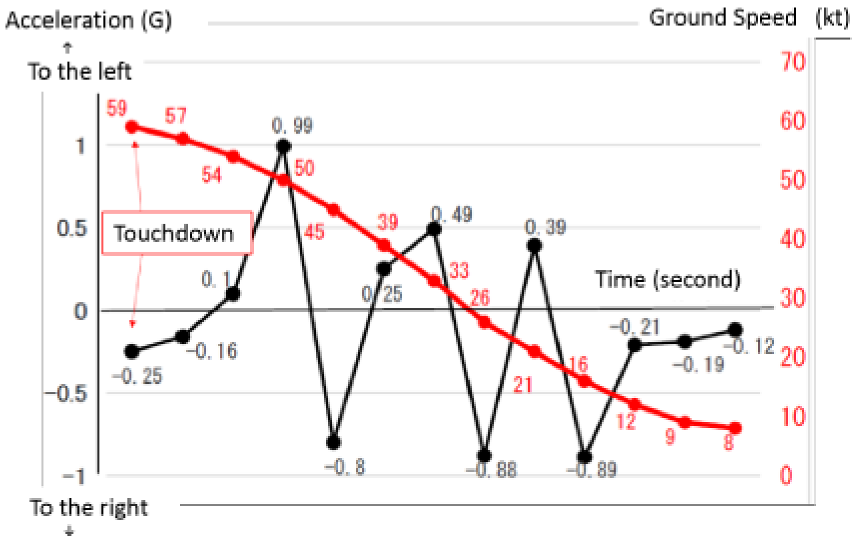


Figure 5 Lateral Acceleration and Ground Speed variations
(Measuring values: once per second)

Table 1 Similar Landing Data

	Date	Arrival Airport	Maximum Lateral Acceleration (G)
1	August 21, 2015	Kagoshima	0.72
2	August 23, 2015	Kagoshima	0.91
3	August 27, 2015	Kagoshima	0.52
4	October 18, 2015	Matsuyama	1.11
5	November 21, 2015	Kagoshima	0.76
6	November 27, 2015	Kobe	1.01
7	November 31, 2015	Kagoshima	0.99

From all ADL records of the landing by the Captain (221 times to be confirmed), there were 56 records to have lateral acceleration swung between + and – in short cycle and 69 records to have lateral acceleration exceeded 0.25 G.

(3) Other Records

Multiple flight data at U.S.A flown by pilots other than the Captain which were recorded in ADL indicated the average ground speed of 14 kt and the maximum ground speed of 20 kt at the time to start a turn to vacate from the runway. Furthermore, lateral acceleration at the time of landing was at range of from 0.07 G to 0.22 G.

2.12 Maintenance Records

2.12.1 Maintenance of the Aircraft

The maintenance company which contracts to implement a maintenance, inspection and others for the Aircraft (hereinafter referred to as "the Maintenance company"), carried out 100-hour inspection on February 10, 2016 for the Aircraft and conducted a normal visual inspection for the nose landing gear, but no abnormality was found. The next periodic inspection (50-hour inspection) will be scheduled on the 338 hours 58 minutes of the total flight time.

2.12.2 Maintenance of the Nose Landing Gear of the Aircraft

The fairing for the nose landing gear of the Aircraft was fixed on the nose landing gear via WPB (Wheel Pant Bracket). This WPB could be deformed when the high stress applied to the nose landing gear, the Maintenance company kept the replacement records of the WPB of the Aircraft as described in Table 2.

Table 2 Records of WPB replacement

Number of Replacement	Date of Replacement	Number of Landing
First time	October 15, 2015	88 times (since receiving the plane)
Second time	December 26, 2015	66 times (since the first replacement)
Third Time	March 13, 2016	63 times (since the second replacement)

There was no malfunction to require to replace WPB of other several aircrafts of the same type managed by the Maintenance company.

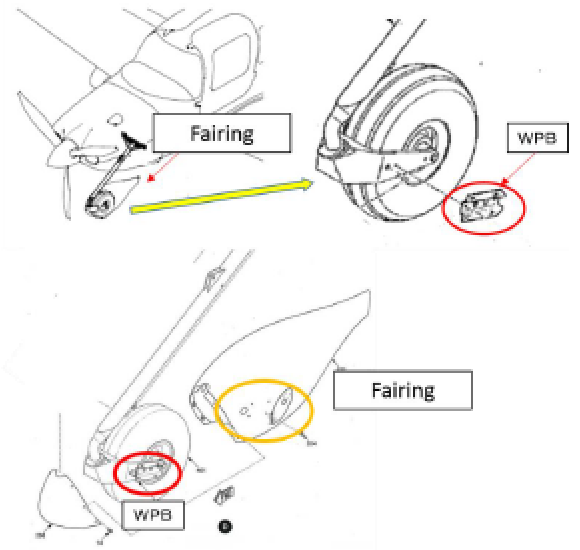


Figure 6 Fairing and WPB

2.12.3 Maintenance Information provided by the Company

The company issued "Service Advisory (SA16-03)" on March 7, 2016 as a maintenance information. The SA instructed to carry out a visual inspection for the welded parts of the nose landing gear strut tube at every time to remove the engine cowling, because cracks were found at the welded part of the nose landing gear strut tube of the same type aircraft.

2.13 Function and Performance of the Aircraft

2.13.1 Aural Warning Function

The autopilot system equipped with the aural warning function, when an autopilot system is engaged, if an aircraft flew slower than the specified airspeed, an aural warning message "Airspeed" informs an imminent "under speed state" (Under Speed Protective Mode). When a 100% flap, the aural warning message shall be activated at airspeed of 80 kt.

2.13.2 Stall Speed

Based on the flight operation manual, the stall speed is airspeed of 64 kt at the weight and the 100 % flap of the occurrence of the serious incident.

2.13.3 Landing Distance

According to the flight operational manual, a landing distance*5 is 2,630 m based on the following conditions with the temperature and pressure height same as at the time of the occurrence of the serious incident, and the ground roll distance*6 is 1,243 ft (378 m).

Condition:

- Wind velocity... zero
- Runway.. Dry, level, paved
- Flap .... 100 %
- Output .... 3° Power Approach
  to 50 FT obstacle, then reduce power passing the estimated 50 foot point and smoothly continue power reduction to reach idle just prior to touchdown.

*5 "Landing Distance" is the horizontal distance taxied by the airplane from the point on the approach course at a height 50 ft above the runway threshold with a selected speed and touched down by pitching up, to the point at where the airplane comes to a complete stop.
*6 "Ground Roll Distance" is the horizontal distance taxied by an airplane from the point of touchdown to the point of a complete stop.

2.13.4 Directional Control at the ground

The nose landing wheel of the Aircraft is a mechanism of a caster which can rotate freely in a range of 85° to left and to right, attached to the nose landing gear strut tube (see Figure 2) and an operation of the airplane on the ground at low speed was controlled by stepping on the right braking pedal and left one of the main landing gear.

3. ANALYSIS

3.1 Qualification of Personnel

The captain held both valid airman competence certificate and valid medical certificate.

3.2 Airworthiness Certificate

The Aircraft had a valid airworthiness certificate and had been maintained and inspected as prescribed.

3.3 Relations to the Meteorological Conditions

As described in 2.6, according to the SPECI after the occurrence of the serious incident, it is probable that the wind blew from the left-tail at average of 7 kt with the variable of wind direction against the approach course, however, it is probable that these were not the conditions to cause troubles for the landing operations of the Aircraft at approach.

3.4 History of the Flight

As described in 2.11.2, after the Aircraft started final approach at the ground altitude 620 ft with the airspeed of 110 kt, the pitch angle started to fluctuate from the ground altitude 400 ft and consequently the fluctuation of the vertical acceleration accompanying this continued up to near the runway threshold. Then, with no more large fluctuation in pitch angle, the Aircraft was led to the touchdown, but the pitch angle of the Aircraft at the time of touchdown was almost at parking attitude. After the touchdown the pitch angle swung up and down for once, then come to be the maximum angle and returned to the parking attitude to be rapidly nose-down condition.

As described in 2.1.2(1), as the Captain pulled the control stick toward his body enough to hold up the nose slightly, held there by a little after the touchdown and released the steering force at passing the taxiway T2, because the nose suddenly dropped down to be in contact with the runway with leaning forward attitude, the Captain stated that he acknowledged the fact of the nose landing gear collapsed.

As described in 2.8.2, the tire marks of the main landing gear wheel were not identified, but there were dark and short matching tire marks in width with the nose landing wheel left at the point of passing the taxiway T2, the propeller hitting marks (slash mark) at 38 m from there and again the scratch marks made by the propeller were left form 17 m ahead to the Aircraft halt position.

From these facts, after the Aircraft continued final approach under the unstable condition, it is probable that the pitch angle had no big fluctuations from the runway threshold and it stayed stable, but the nose up at the touchdown was not enough and the nose landing gear and the main landing gear landed at the same time. After this, it is probable that after the Aircraft pitched the nose up and down then touched down the nose landing wheel again strong enough to leave dark contact marks of the nose landing wheel, the nose landing gear strut tube was collapsed and the tip of the propeller ran for a short while as in contact with the runway, lowered the nose further down and stopped as it contacted with the runway.

3.5 Judgments and Operations by the Captain

3.5.1 Judgments and operations from the approach to the touchdown

As described in 2.1.2(1), the Captain stated that he set down the flap to 100 % at final approach, kept to approach at airspeed of 90 kt, and touched down around abeam of PAPI, however, according to the records of ADL, final approach of the Aircraft was at airspeed of 110 kt.

It is probable that the Captain was making approach at the airspeed which was about 20 kt greater than the approach speed (80 to 85 kt) specified in the Flight Operation Manual described in 2.10.1, even though he did not used the autopilot system, because he did not want to activate the aural warning message "AirSpeed" of the Aircraft autopilot system described in 2.13.1. Furthermore, as described in 2.1.2(1), it is somewhat likely that his memory of the instruction "keep the speed of 90 kt to approach" he had received from the Instructor affected.

As described in 3.4, it is probable that the pitch control become unstable from the midway of final approach of the Aircraft, this unstable pitch-control remained until near the runway threshold, then started to operate touchdown.

Regarding the reason that the pitch-control of the Aircraft become unstable, it is somewhat likely that adding to a stronger effectiveness of the rudder, etc. due to the greater speed than normal approach speed, the corrective operation by the Captain become too excessive, because the Captain had the impression which the approach phase could be rough when the wind blew diagonally from tail.

As described in 2.11.2 and 2.13.2, the airspeed was 77 kt when the Aircraft touched down and the stall speed was 64 kt at the time of the serious incident. As described in 2.1.2(1), it is somewhat likely that the Captain mistook the stall speed of the Aircraft as 78 kt. According to the pilot textbook described in 2.10.2, because the ideal touchdown speed is closed to the stall speed for the airplane speed to touch down from the main landing gear, it is probable that the touchdown speed of the Aircraft could be 10 kt or more than the normal speed.

Then, as described in 3.4, it is probable that the large load to cause the fracture of the nose landing gear was applied when the Aircraft pitched the nose up and down then touched down again the nose landing wheel. Regarding the unstable pitch-control, because the speed at the touchdown was too fast, it is probable that the corrective operation could become excessive at the same as final approach.

3.5.2 Ground Roll after the touchdown

As described in 2.1.2(1), it is somewhat likely that the Captain intended to vacate from the taxiway T2 after landing on the runway 34. Based on the records of ADL, the position where the Aircraft touched down was about 340 m inside of the runway threshold, and the distance from this point to the taxiway T2 is about 150 m. As described in 2.13.3, based on the performance table of the flight operation manual, the ground roll distance after the touchdown shall be about 380 m as required and at normal landing operation, it is difficult to vacate from the taxiway T2 after reducing the speed sufficiently.

As described in 2.11.3(1), there were many records of the landing operation to land on the runway 34 at the airport and vacate from the taxiway T2. According to the records, the Aircraft had touched down at the approximately 270 m inside as average from the runway threshold, the maximum ground speed was 49 kt at the time to start the left turn to vacate the runway and had decelerated the speed rapidly during the time to change directions to enter the taxiway T2. Furthermore, among all landing records of the Aircraft, many records indicated the speed exceeding 25 kt to start the left turn to vacate the runway. Based on these, it is probable that the Captain had operational tendencies at the ground roll operation to initiate the left turn in order to vacate the runway without sufficient deceleration.

As described in 2.11.3(2), because there were many records indicating the big variation in lateral acceleration after the touchdown, it is somewhat likely to indicate the possibilities of repeated occurrences of the shimmy. Furthermore, as described in 2.1.2(1), the Captain had experienced the vibration of the nose landing gear after touchdown, up to then.

Furthermore, as described in 2.12.2, because there were records to replace the WPB three times within a short while, it is somewhat likely that the Aircraft repeated landings with applying high stress onto the nose landing gear.

From these, it is probable that the load due to the occurrences of shimmy after the touchdown and the repeated left turn with greater speed than a normal to vacate the runway by the captain, affected the nose landing gear strut tube.

3.6 Damages of the Airframe

3.6.1 Generation of the crack

As described in 2.9.2, based on the verification test using an aircraft at the Company, the shimmy could be generated for a short while at light lever, at the time, the nose landing gear strut tube suffered substantial strain. Based on this, under more sever shimmy with longer durations, it is indicated the possibilities to generate cracks.

As described in 3.5.2, at landing of the Aircraft, it is somewhat likely that there were possibilities of many prior occurrences of the shimmy. It is somewhat likely that the repeated occurrences of the shimmy contributed to the generation of the crack at the Edge of the strut tube of the Aircraft.

3.6.2 Progress of the Crack

Based on the fracture surface analysis done at NTSB, it is highly probable that the crack was progressed by the repeated application of the load.

As shown in Figure 4, the progress of the crack indicated by the red arrows at the fracture surface of the nose landing gear strut tube were seen evenly on the right and the left and it is somewhat likely that the repeated occurrences of shimmy contributed, mainly.

Furthermore, about the large progress of the crack in the yellow arrows which is spreading at outside of the red arrows and seen only at the left side of the airframe on the fracture surface, as described in 3.5.2, it is probable that it is because of the operation to start the left turn without sufficient deceleration in order to vacate the runway after landing, and it is probable that a high tensile force were generated due to the moment to bend the strut tube to the right wing side on the left side of the Edge of the strut tube. It is probable that the open cracks were progressed from the left side of the nose landing gear strut tube because this operation were executed for many times at landing, at each time a high stress was generated on the strut tube end, repeatedly.

3.6.3 Fracture of the Strut Tube Assembly of the Nose Landing Gear

As described in 3.6.2, it is probable that because the strength of the nose landing gear strut tube decreased significantly due to the progress of the open crack, the nose landing gear strut tube resulted in the fracture, attributable to the load of the landing at the time of the occurrence of the serious incident. Thereby, it is highly probable that downing the nose had the propellers in contact with the runway and caused the damages to the airframe.

3.7 Maintenance and others

As described in 2.12.1, the Aircraft had received the designated inspections and no anomaly was found on the last 100-hours inspections (inspected on February 10, 2016). As described in 2.12.3, it is probable that the inspections relating to the maintenance information (SA16-03) by the Company was not carried out, because there was no chance to remove the engine cowling during the time till the occurrence of this serious incident.

4. PROBABLE CAUSES

It is certain that this serious incident occurred as the Aircraft was unable to taxi itself because the Aircraft had fractured its nose landing gear strut tube at landing and halted as leaning forward condition while the nose of the Aircraft was in contact with the runway.

Regarding the fracture of the nose landing gear strut tube, it is probable that because undetected fatigue crack which had been generated at the Edge of the strut tube prior to the occurrence of the serious incident progressed and the strength of the nose landing gear strut tube was decreased significantly, the load which was applied on the nose landing gear at landing of this serious incident resulted in the fracture.

Regarding the initiation and progression of the fatigue crack at the Edge of the strut tube, it is somewhat likely that the repeated occurrences of the shimmy at landing of the Aircraft had contributed.

In addition, it is probable that the repeated application of high tensile stress onto the left side of the Edge of the strut tube had contributed to the progress of the crack, because the captain had operational tendencies to initiate the left turn at the speed which the Aircraft did not decelerate sufficiently in order to vacate the runway after landing.

5. SAFETY ACTIONS

5.1 Measures Taken by Manufacturer

5.1.1 Addition of Maintenance Information

The Company issued Service Bulletin (SB2X-32-22) as an additional maintenance instruction regarding the inspection of the crack found at the welded part of the nose landing gear strut tube of the type of an aircraft on April 12, 2016 after the occurrence of the serious incident. The SB has the contents to

① Carry out it at the next maintenance inspection or within the next 50-hours flight time, whichever occurs first.

② Carry out it with the tools used for inspections (Flashlight, Inspection Mirror, 10×Magnifier, Mid Dishwasher Soap and Cotton Cloth), and in accordance with the Instruction method/procedure.

③ Report results of a maintenance inspection to the Company.

5.1.2 Addition of Inspection

The Company decided to incorporate a special inspection (the same as above mentioned maintenance instruction) after an occurrence of Shimmy in addition to the inspection according to SB as described in 5.1.1, into the Maintenance Procedure.

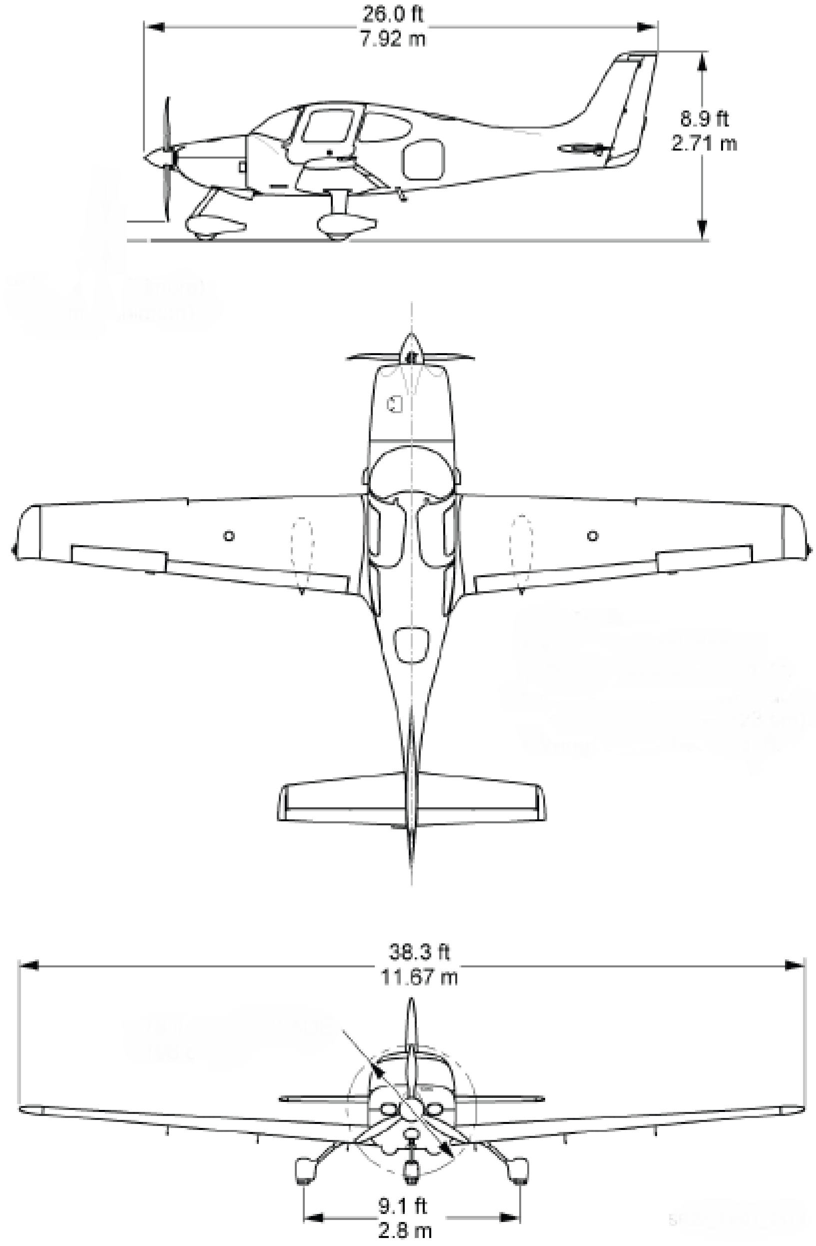
5.1.3 Design Changes

The Company examined the increasing a thickness around the welded part of the nose landing gear strut tube in order to improve the strength of the welded part of the nose landing gear strut tube, and decided to apply it for all of the nose landing gear to be newly manufactured and to be replaced after 2017.

5.1.4 Changes of the contents of Pilot training

The Company decided to incorporate the preventive measure for an occurrence of shimmy and the countermeasure to take when a shimmy occurs into training materials for a pilot.

Appended Figure 1: Three Angle View of Cirrus SR22



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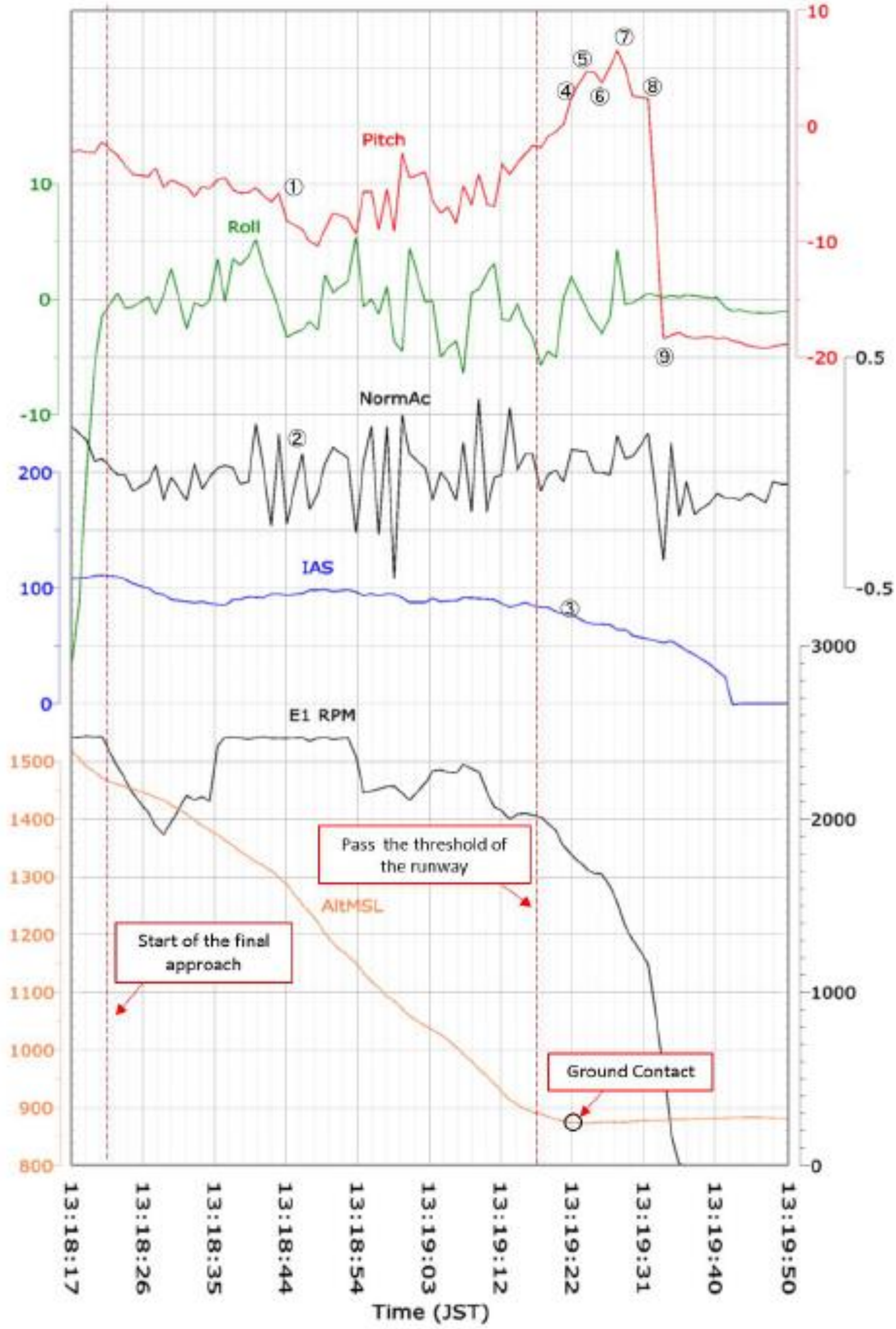
Appended Figure 2: Records of ADL



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