

AI2023-6

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

**Independent Administrative Institution Civil Aviation College
J A 0 1 7 C**

September 28, 2023



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.

TAKEDA Nobuo
Chairperson
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.

《Reference》

The terms used to describe the results of the analysis in "3. ANALYSIS" of this report are as follows.

- i) In case of being able to determine, the term "certain" or "certainly" is used.
- ii) In case of being unable to determine but being almost certain, the term "highly probable" or "most likely" is used.
- iii) In case of higher possibility, the term "probable" or "more likely" is used.
- iv) In a case that there is a possibility, the term "likely" or "possible" is used.

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

INABILITY TO OPERATE DUE TO DAMAGES OF THE LANDING GEAR OF THE AIRCRAFT

CIRRUS SR22, JA017C

INDEPENDENT ADMINISTRATIVE INSTITUTION

CIVIL AVIATION COLLEGE

AT OBIHIRO AIRPORT

AT ABOUT 11:30 JST, APRIL 17, 2020

August 25, 2023

Adopted by the Japan Transport Safety Board

Chairperson TAKEDA Nobuo
Member SHIMAMURA Atsushi
Member MARUI Yuichi
Member SODA Hisako
Member NAKANISHI Miwa
Member TSUDA Hiroka

1. PROCESS AND PROGRESS OF THE AIRCRAFT SERIOUS INCIDENT INVESTIGATION

1.1 Summary of the Serious Incident	On Friday, April 17, 2020, when a Cirrus SR22, JA017C, operated by the Independent Administrative Institution Civil Aviation College, landed at Obihiro Airport, the nose landing gear was damaged and it stopped on the runway. After that, the aircraft became unable to continue its taxiing.
1.2 Outline of the Serious Incident Investigation	The occurrence covered by this report falls under the category of “Case where aircraft landing gear is damaged and thus flight of the aircraft may not be continued” as stipulated item (viii), Article 166-4 of Ordinance for Enforcement of Civil Aeronautics Act (Ordinance of Ministry of Transport No. 56 of 1952) prior to revision by the Ministerial Ordinance on Partial Revision of the Ordinance for Enforcement of Civil Aeronautics Act (Ordinance of Ministry of Land, Infrastructure, Transport and Tourism No. 88 of 2020), and is classified as a serious incident.

On April 17, 2020, the Japan Transport Safety Board (JTSB) designated an investigator in-charge and an investigator to investigate this serious incident.

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

Comments on the draft Final Report were invited from parties relevant to the cause of the serious incident and the Relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight

According to the statements of the captain, the trainees and the air traffic controller of the tower control position of the Obihiro Airport Traffic Control Tower as well as the records of the flight data recorder on the aircraft, the history of the flight is summarized below.

On April 17, 2020, at Obihiro Airport, a Cirrus SR22, JA017C, operated by the Independent Administrative Institution Civil Aviation College, was conducting the continuous touch-and-go training, which was the fourth flight of the day by the aircraft, with the captain as the flight instructor seated in the right pilot seat, the trainee in charge of pilotage of the aircraft seated in the left pilot seat, and other two trainees observing the training seated in the aft seats.

The aircraft finished the touch-and-go, and when it was piloted by the trainee and landed at Obihiro Airport, the aircraft attitude became suddenly tilted forward about four seconds after the nose landing gear (NLG) touchdown. Therefore, judging that there occurred some abnormality in the NLG, the captain shut down the engine promptly and stopped the aircraft on the runway by applying the brakes. The approach and touchdown were performed normally, and during this flight training including the landing, none of the occupants recognized any troubles in the aircraft.

On the day, in the three flight trainings performed before this serious incident occurred, including the pre-flight check, there were no problems with the aircraft, and the take-off and landing were carried out normally.

This serious incident occurred at about 11:30 Japan Standard Time (JST: UTC + 9 hours; unless otherwise stated all times are indicated in JST on a 24-hour clock), on April 17, 2020, on the runway at Obihiro Airport.

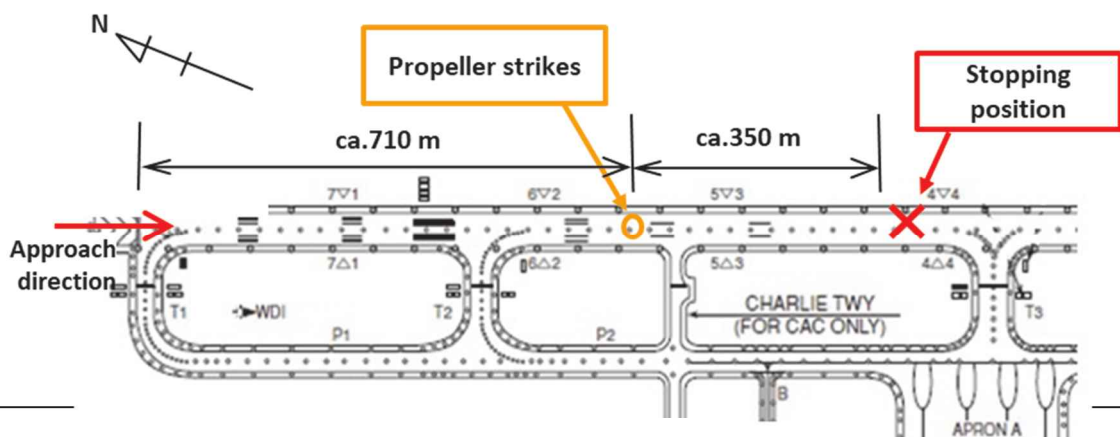


Figure 1: Condition of Runway

<p>2.2 Injuries to Persons</p>	<p>None</p>
<p>2.3 Damage to the Aircraft</p>	<p>The following damage was confirmed during the airframe inspection after the serious incident, (see Figure 2-2).</p> <ul style="list-style-type: none"> • NLG Oleo*¹ (shock absorber): Its piston rod was got out of the cylinder and separated. • Propeller blades: All the propeller blades' (three) tips were bent backward. • Fairing of the lower nose surface: It was deformed inward. • NLG strut fairing: its tip was broken. • Firewall*²: There were two dents on the lower end struck by the NLG strut. <div data-bbox="427 645 1385 1310" data-label="Image"> </div> <p>Figure 2-1: Normal Condition of the NLG (Cirrus SR22 Model) and structural drawing (with the NLG strut fairing removed)</p>

*¹ An “Oleo” refers to a shock absorber used to cushion the impacts applied through the nose landing gear of aircraft at the time of taking off, landing and taxiing.

*² A “Firewall” is a flameproof bulkhead that separates the engine compartment from the cockpit to prevent a fire in an aircraft engine from spreading to the cockpit.

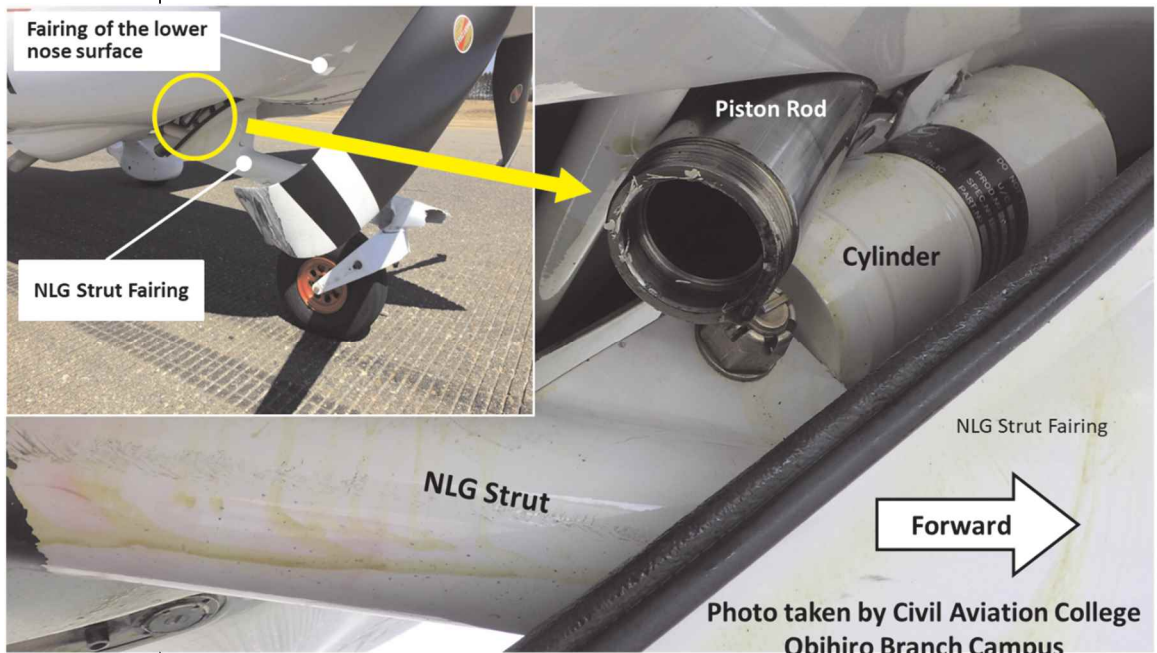


Figure 2-2: Oreo Separation Status

<p>2.4 Personnel Information</p>	<table border="0"> <tr> <td>Captain</td> <td>Age: 44</td> </tr> <tr> <td>Commercial pilot certificate (Airplane)</td> <td>July 24, 1998</td> </tr> <tr> <td>Specific pilot competence</td> <td></td> </tr> <tr> <td>Expiry of practicable period for flight:</td> <td>April 26, 2021</td> </tr> <tr> <td>Rating for single-engine land</td> <td>July 14, 2006</td> </tr> <tr> <td>Class 1 aviation medical certificate</td> <td>Validity: May 24, 2020</td> </tr> <tr> <td>Flight instructor certification</td> <td>November 7, 2007</td> </tr> <tr> <td>Total flight time</td> <td>4,994 hours 28 minutes</td> </tr> <tr> <td>Total flight time on the type of aircraft</td> <td>923 hours 35 minutes</td> </tr> <tr> <td>Trainee (Person in charge of pilotage of the aircraft)</td> <td>Age: 25</td> </tr> <tr> <td>Student pilot permission</td> <td>Validity August 1, 2020</td> </tr> <tr> <td>Total flight time</td> <td>30 hours 05 minutes</td> </tr> <tr> <td>Total flight time on the type of aircraft</td> <td>30 hours 05 minutes</td> </tr> </table>	Captain	Age: 44	Commercial pilot certificate (Airplane)	July 24, 1998	Specific pilot competence		Expiry of practicable period for flight:	April 26, 2021	Rating for single-engine land	July 14, 2006	Class 1 aviation medical certificate	Validity: May 24, 2020	Flight instructor certification	November 7, 2007	Total flight time	4,994 hours 28 minutes	Total flight time on the type of aircraft	923 hours 35 minutes	Trainee (Person in charge of pilotage of the aircraft)	Age: 25	Student pilot permission	Validity August 1, 2020	Total flight time	30 hours 05 minutes	Total flight time on the type of aircraft	30 hours 05 minutes
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<p>2.5 Aircraft Information</p>	<table border="0"> <tr> <td>Aircraft type:</td> <td>Cirrus SR22</td> </tr> <tr> <td>Serial number: 4417</td> <td>Date of manufacture: November 2, 2016</td> </tr> <tr> <td>Airworthiness certificate: No.TOU-2019-459</td> <td>Validity: December 24, 2020</td> </tr> <tr> <td>Total flight time</td> <td>956 hours 15 minutes</td> </tr> </table>	Aircraft type:	Cirrus SR22	Serial number: 4417	Date of manufacture: November 2, 2016	Airworthiness certificate: No.TOU-2019-459	Validity: December 24, 2020	Total flight time	956 hours 15 minutes																		
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<p>2.6 Meteorological Information</p>	<p>The observation data in the aerodrome routine meteorological report (METAR) at Obihiro Airport were as follows:</p> <p>11:00 Wind direction: 150°, Wind velocity: 5 kt, Directional fluctuation 060°-210°, Visibility 10 km or more Clouds: Amount 1/8, Type Cumulus, Cloud base 5,000 ft Temperature 9 °C, Dew point -4 °C, Altimeter setting (QNH) 1,022 hPa, 30.19 inHg</p>																										
<p>2.7 Additional Information</p>	<p>(1) Structure of the Same Type Oleo and Failure Cases on Assembling</p> <p>The Oleo of the aircraft is designed to tighten the fittings (hereinafter referred to as “Piston Rod Locknut”) that prevents the Piston Rod from being got out of the cylinder and then fasten one Piston Rod Locknut Grub</p>																										

Screw (hereinafter referred to as “Grub Screw”) that prevents the Piston Rod Locknut from loosening due to its rotating. As being installed inside the Oleo, the Grub Screw was not visible from the outside unless the oleo was disassembled (see Figure 3-1).

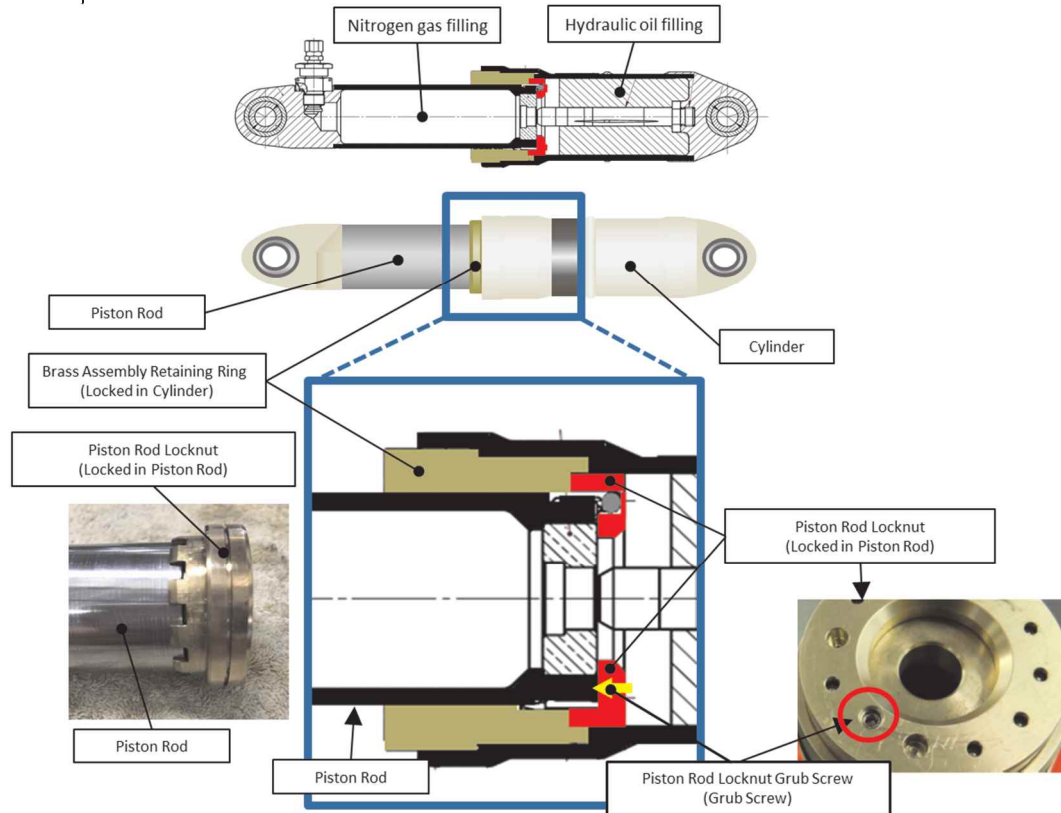


Figure 3-1: Structure of the Oleo

On September 30, 2019, in the United Kingdom, there occurred a failure incident where a Piston Rod was got out of the cylinder of the same type of the Oleo, and the manufacturer of the Oleo conducted an investigation into the cause. As a result of the investigation, it was revealed that when the Piston Rod Locknut was tightened*³ into the Piston Rod in the Oleo’s assembly line, the Grub Screw was tightened while the positions of the dimple (1 place) machined on the Piston Rod and the Grub Screw hole in the Piston Rod Locknut was misaligned. Therefore, as their used repeatedly, the Piston Rod Locknut rotated, the Piston Rod Locknut was detached from the Piston Rod, and the Piston Rod was got out of the cylinder (see Figure 3-2).

There are four reports about the failure case where a Piston Rod was detached from the cylinder of the same type of the Oleo other than this serious incident, confirmed were a total of two failure cases same as that in the United Kingdom introduced in this chapter. These four failures occurred possibly due to the inappropriate tightening of the Grub Screw at the time of manufacturing, it was revealed that the Oleos manufactured in the same period as the failed Oleo would likely cause the same trouble. Therefore, the aircraft manufacturer issued the Service Bulletin to inform that the Oleos

*³ The Piston Rod and Piston Rod Locknut are threaded, and they are fixed by screwing the Piston Rod Locknut onto the Piston Rod using their screw threads on both parts.

manufactured in the same period as the failed Oleo should be replaced on December 11, 2020 after this serious incident occurred.

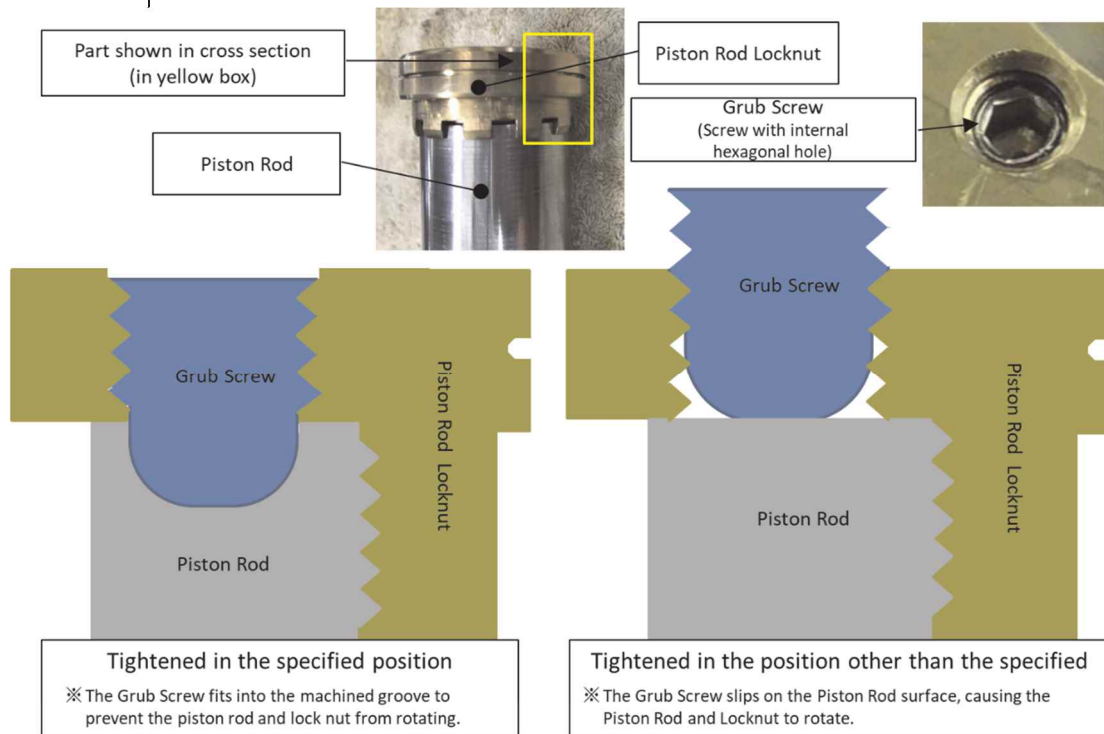


Figure 3-2: Mechanism for Grub Screw (Image)

The same type of the Oleos, whose Grub Screw was possibly not tightened at the specified position at the time of manufacturing, were shipped from February 28, 2014 to August 28, 2018, and the Oleo that had been installed in the aircraft (JA017C) was shipped on August 28, 2018.

(2) Detailed examination of the Oleo of the Aircraft

The detailed examination of the Oleo of the aircraft revealed that the Piston Rod Locknut was detached from the Piston Rod, the Grub Screw was not found during the aircraft examination and also from the inside of the Oleo. Besides, on the surface of the Piston Rod, no contact marks created when screwing the Grub Screw were confirmed, therefore it revealed that at the time of manufacturing, the Grub Screw had most likely not been installed.

Regarding the possibility that the Grub Screw would be lost after the installation, the Oleo manufacturer said that if the Grub Screw had been tightened in the position other than the specified one like in the same way as those in the failure cases shown in (1), they were unable to deny the possibility of the Grub Screw loss after the installation, but it would be unlikely.

In addition, the defective Oleos of the Cirrus SR22 probably caused due to the failure in manufacturing operations were confirmed in the two cases in the world before the occurrence of this serious incident, and when this serious incident occurred, the aircraft manufacturer was in the middle of investigating it on whether such defective products occurred due to individual anomaly event or some common causes.

(3) Maintenance History of NLG Oleo

The NLG Oleo was installed on the aircraft on December 18, 2018, and this serious incident occurred on the 1,588th landing (including the continuous touch-and-go) after the Oleo was installed.

The most recent Oleo inspection and maintenance work before this serious incident was conducted during the regular maintenance on April 15, 2020, and no defects was confirmed. According to the maintenance manual of the aircraft, the inspection items in that maintenance were only those related to the exterior inspection of the Oleo, and there was no requirement to inspect the internal status of the Oleo.

(4) Flight Data Records of the Aircraft

According to the records of the Recoverable Data Module on board the aircraft, the changes in the aircraft's pitch angle at the time of the occurrence of the serious incident were as shown in Figure 4.

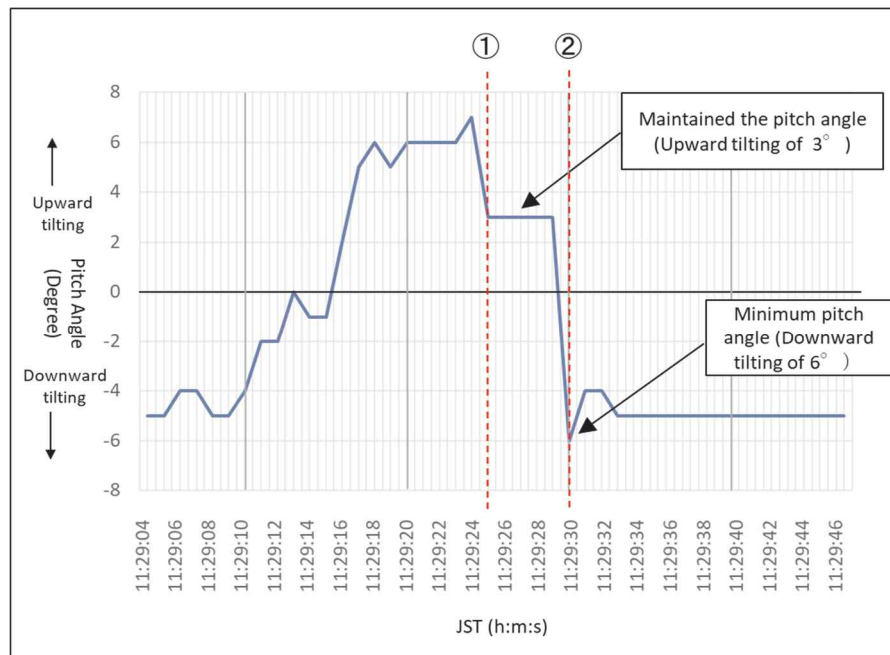


Figure 4: Changes in Pitch Angle

(For “①” and “②” in the Figure, see “3. ANALYSIS (2)” in this report.)

3. ANALYSIS

(1) Separation of NLG Oleo

The JTSTB concludes that it is certain that the aircraft was unable to continue taxiing because the Piston Rod of the aircraft was separated from the NLG Oleo cylinder, and the aircraft attitude became excessively tilted forward. The separation of the NLG Oleo cylinder and the Piston Rod was most likely caused by the Piston Rod Locknut detaching from the Piston Rod. Judging from the fact that the Grub Screw was not found during this investigation, the reason why the Piston Rod Locknut was detached is most likely because since the Grub Screw had not been installed or the Grub Screw had been tightened at the improper position at the time of manufacturing, the Piston Rod Locknut was loosened to be detached from the Piston Rod as they were used repeatedly, and due to the nitrogen gas pressure inside the Oleo and the NLG's own weight, the Piston Rod was most likely got out of the Oleo cylinder.

The Operator is unable to inspect the Grub Screw position directly. Therefore, it is necessary for the Oleo manufacturer to conduct a review of the manufacturing procedures so that the work for tightening the Grub Screw shall be appropriately carried out in order to ensure the soundness of the same type of the Oleo.

(2) Situation Leading up to Separation of the NLG Oleo Cylinder and Piston Rod

The JTSC concludes that the separation of the NLG Oleo cylinder and the Piston Rod was more likely occurred during the time from the take-off on the touch-and-go conducted just before the occurrence of this serious incident until the final landing based on the following:

- No abnormality was confirmed until the take-off conducted on the touch-and-go just before the occurrence of this serious incident.
- The dents on the firewall (see (3) in this Chapter) were more likely created when the NLG strut moved downward beyond normal operating range, the NLG strut came in contact with the lower part of the firewall. Such NLG strut movement would not occur during taxiing.

The aircraft maintained its attitude tilted upward at 3° (an upward tilting of about 1° for a normal taxiing) for about four seconds from the time when the NLD seemed to have touched down (red dotted line ① in Figure 4), and then its nose became down radically and its attitude became tilted downward at the maximum angle of 6° (red dotted line ② in Figure 4). The aircraft was in an upward tilting attitude for about four seconds from the time when the NLG touched down, during which the NLG more likely supported the airframe. This is probably because the form was created where the Piston Rod separated at the time of the touchdown was on top of cylinder.

The radical nose down that occurred after the aircraft maintained its attitude tilted upward probably resulted from the Piston Rod riding on top of cylinder falling down, caused due to vibrations during the taxiing after the NLG touchdown and/or brake operational control (see Figure 5).

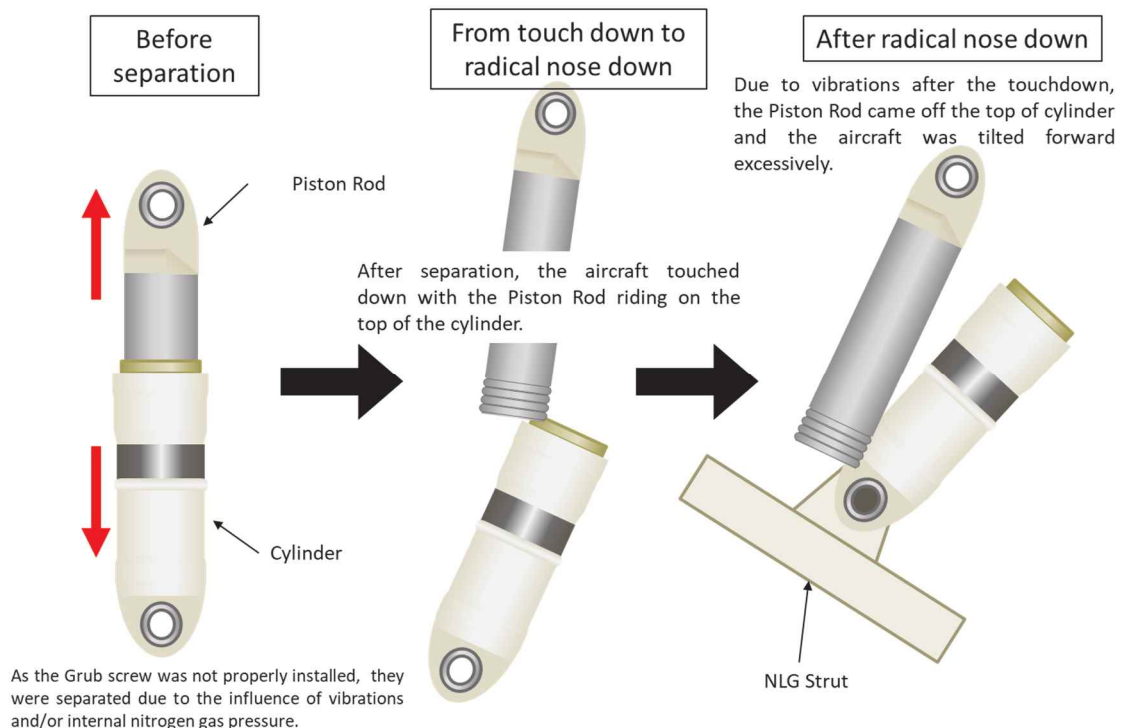


Figure 5: Separation Process of the Oleo

(3) Damage to the Aircraft

The JTSTB concludes that it is highly probable that from the flight data records, the aircraft attitude became radically tilted downward at the maximum angle of 6° after its NLG touched down (red dotted line ② in Figure 4), and when the aircraft became in this attitude, the tip of NLG strut fairing, which was pushed forward due to the runway surface and the excessive downward tilting attitude, came in contact with the propeller blades, resulting in the damage to the propeller blade tips and the NLG fairing tip (see Figure 6).

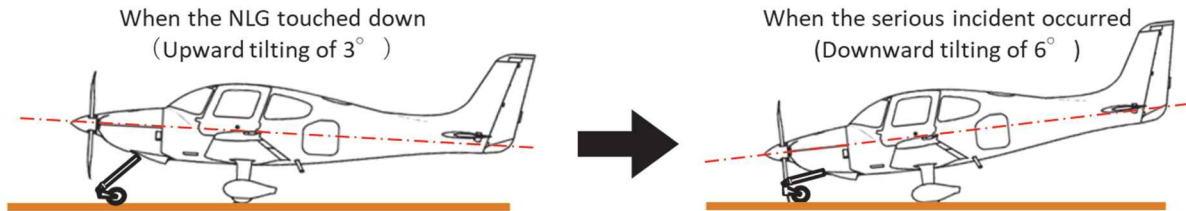


Figure 6: Aircraft Attitude at the Time of the Serious Incident (Estimate)

In addition, the dents on the firewall were more likely created when the NLG strut moved downward beyond normal operating range (see Figure 7) as the Oleo was separated during the flight, and the damage to the fairing of the lower nose surface were probably sustained due to interference with the NLG fairing when the aircraft was excessively tilted downward after the landing, respectively.

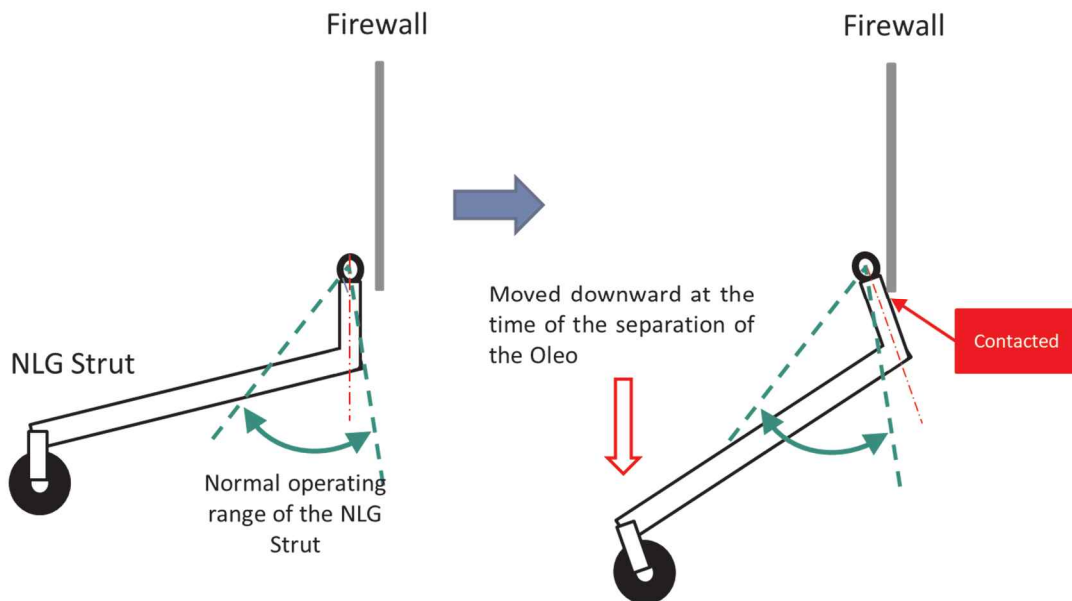


Figure 7: Contact between Firewall and NLG Strut (Image)

(4) Maintenance Work for the NLG Oleo

The JTSTB concludes that it is certain that the required inspection and check of the NLG Oleo were conducted according to the maintenance manual of the aircraft. As described in 2.7 (3) of this report, the inspection items specified in the manual did not include the requirement for users to conduct the interior inspection, in addition, the Grub Screw is installed in the place not allowing for an exterior inspection, thus it is most likely that it was impossible to find the manufacturing operations failure and the defects caused by such failure at the time of the regular maintenance.

4. PROBABLE CAUSES

The JTSTB concludes that it is certain that the probable cause of this serious incident was that the aircraft landed with the Piston Rod separated from the NLG Oleo cylinder, and the aircraft was excessively tilted downward during the landing roll.

The reason why the Piston Rod was separated from the NLG Oleo cylinder is probably because in the manufacturing operation for the Oleo that was installed on the aircraft, the assembly work for the Piston Rod and the Piston Rod Locknut was not conducted appropriately, and as take-offs and landings were repeated, the Piston Rod Locknut was detached from the Piston Rod.

5. SAFETY ACTIONS

5.1 Safety Actions Required	As described in 3. ANALYSIS, the Oleo manufacturer shall improve the manufacturing procedures to ensure the Oleo assembly work.
5.2 Safety Actions Taken after the Serious Incident	(1) The Oleo manufacturer took the following safety actions. a. Made this serious incident to the Oleo assembly workers b. Enhanced the confirmation procedures for tightening the Grub Screw (2) The designer/manufacturer of the aircraft issued a Service Bulletin to instruct replace the NLG Oleos having potential manufacturing defects on December 11, 2020.