

AI2017-2

**AIRCRAFT SERIOUS INCIDENT
INVESTIGATION REPORT**

**PRIVately OWNED
J A 3 0 H T**

June 29, 2017



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 MAULE AIR M-7-235C
JA30HT

INABILITY TO OPERATE DUE TO DAMAGES OF THE
LANDING GEAR OF THE AIRCRAFT
AT OTONE TEMPORARY AIRFIELD
KAWACHI TOWN, INASHIKI-GUN, IBARAKI PREFECTURE
JAPAN
AT AROUND 11:30, DECEMBER 4, 2015

May 26, 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

1 PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Serious Incident	On Friday, December 4, 2015, a privately owned Maule Air M-7-235C, registered JA30HT, damaged the tailwheel during its taxiing to an apron after landing at Otone Temporary Airfield, therefore, the aircraft could not be continued taxiing and stopped in front of the apron.
1.2 Outline of the Serious Incident Investigation	This event fell under the category of “Case where an aircraft landing gear is damaged and thus flight of the subject aircraft could not be continued” as stipulated item (VIII), Article 166-4 of Ordinance for Enforcement of Civil Aeronautics Act, which was

	<p>classified as an aircraft serious incident.</p> <p>On December 4, 2015, the Japan Transport Safety Board (JSTB) designated an investigator-in-charge and an investigator to investigate this serious incident.</p> <p>An accredited representative of United States of America as the state of Design and Manufacturer of the aircraft involved in this serious incident, participated in this investigation.</p> <p>Comments were invited from the parties relevant to the cause of the serious incident and the relevant State.</p>
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2 FACTUAL INFORMATION

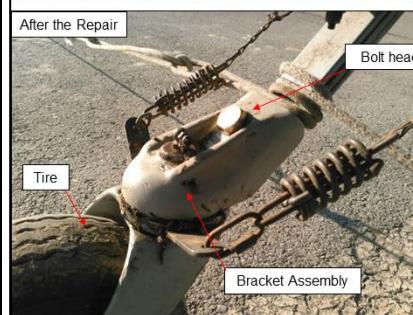
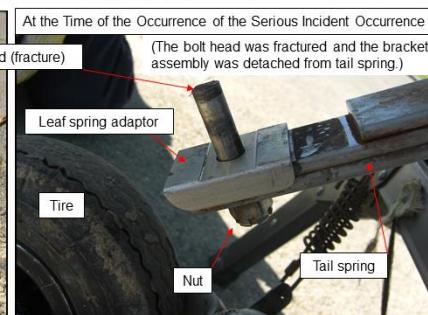
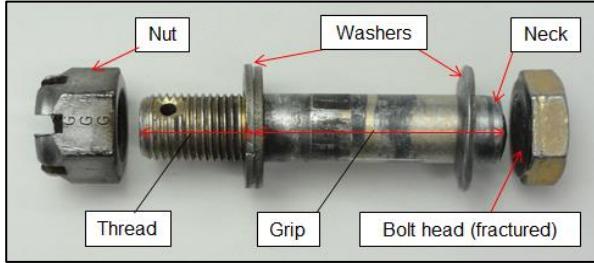
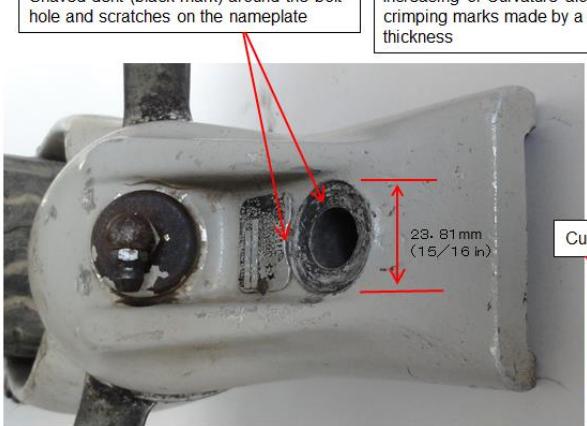
2.1 History of the Flight	<p>According to the statements of the captain and a maintenance technician who works for the entrusted company with a maintenance of the aircraft, the history of the flight is summarized as follows:</p> <p>A privately owned Maule Air M-7-235C, registered JA30HT took off from the Otone Temporary Airfield at 11:10 for airworthiness inspection with the captain and two passengers on board, and landed on the Temporary Airfield at 11:30. When the aircraft taxied to the parking via compacted and levelled route</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>After the Repair</p> <p>Tailwheel</p> </div> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>After the Repair</p> <p>Tire</p> <p>Bracket Assembly</p> <p>Bolt head (fracture)</p> </div> <div style="text-align: center;">  <p>At the Time of the Occurrence of the Serious Incident Occurrence</p> <p>(The bolt head was fractured and the bracket assembly was detached from tail spring.)</p> <p>Leaf spring adaptor</p> <p>Tire</p> <p>Nut</p> <p>Tail spring</p> </div> </div> </div>
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Photo1 The Condition of the Aircraft and the Tailwheel

	<p>from the runway at the speed of about five kt after the landing, the captain felt something unusual; therefore, he stopped the aircraft. When the captain got off the aircraft to check the airframe, the bolt which had connected the tailwheel bracket assembly of the tailwheel with the tail spring of the airframe side was fractured at the bolt head; therefore, the tailwheel was detached and fallen.</p> <p>The serious incident occurred at around 11:30 on December 4, 2015, at the Otone Temporary Airfield ($35^{\circ}51'29''$ N, $140^{\circ}14'16''$ E).</p>
2.2 Injuries to Persons	None
2.3 Damage	<p>(1) Extent of damage to the aircraft: Slightly damaged (2) Damage to the aircraft component: Detachment of the tailwheel</p> <p>The tail spring and the tailwheel bracket assembly were connected by using three pieces of washers in total which were used one for the bolt head side and two for the nut side, the damages were found as follows:</p>  <p style="text-align: center;">Photo 2 The Bolt, the Washers and the Nut</p>  <p>Shaved dent (black mark) around the bolt hole and scratches on the nameplate</p> <p>Increasing of Curvature along the shaved dent. Multiple crimping marks made by a bolt head, decreasing of the thickness</p> <p>23.81 mm (15/16 in)</p> <p>22.23 mm (14/16 in)</p> <p>(At the bolt head side)</p> <p>Curvature along the shaved dent</p> <p>(At the back side of the washer)</p> <p style="text-align: center;">Photo 3 The Tailwheel Bracket Assembly and the Washer</p>

	<p>a. The Bolt was fractured at right below the bolt head (Neck).</p> <p>b. A shaved dent in the size of 0.6 mm (3/128 in) was found around the bolt hole at the bolt head side of the tailwheel bracket assembly.</p> <p>c. The washer at the bolt head side was curved along the shaved dent, had multiple crimping marks by the bolt head and decreased its thickness.</p> <p>(3) Investigation by using unused items</p> <p>Replacing to a new bolt and new washers and applying a standard torque on the bolt of the tailwheel bracket assembly with a shaved dent used in the aircraft, the washer was slightly curved at the afloat state from the shaved dent but had no crimping marks and did not decrease in its thickness like the washer used for the aircraft.</p> <p>(See Appendix 1: Diagram to Install a Tailwheel)</p>
2.4 Personnel Information	<p>Captain male, age 35</p> <p>Commercial pilot certificate (Aircraft) June 2, 2009</p> <p>Type Rating for Single engine (Land) November 8, 1999</p> <p>Class 1 aviation medical certificate</p> <p>Valid until June 7, 2016</p> <p>Pilot competency assessment</p> <p>Expiration date of piloting capable period January 20, 2016</p> <p>Total flight time 3,484 hours 36 minutes</p> <p>Flight time in the last 30 days 7 hours 50 minutes</p> <p>Total flight time on the type of aircraft 780 hours 50 minutes</p> <p>Flight time in the last 30 days 0 hour 20 minutes</p>
2.5 Aircraft Information	<p>(1) Aircraft type: Maule Air M-7-235C</p> <p>Serial number: 25001C</p> <p>Date of manufacture: March 7, 1996</p> <p>Certificate of Airworthiness: Dai-To-26-419</p> <p>Validity: November 21, 2015</p> <p>Category of airworthiness: Aircraft, normal N or Specific Aircraft X</p> <p>Total flight time: 1,426 hours 34 minutes</p> <p>Flight time after the last periodical check (annual check: carried out on November 21, 2015): 0 hour 20 minutes</p>

	<p>In addition, the flight time is 87 hours 21 minutes and the number of take-offs/landings is 700 times/700 times since the last periodical check carried out on November 21, 2014, when a bolt had been replaced to the bolt which was broken at this serious incident.</p> <p>(2) When the serious incident occurred, the weight of the aircraft is estimated to have been 1,063.7in kg (2,345 lb) and the location of the center of gravity (C.G.) is estimated to have been at 457.2 mm (18 in) aft of the reference point and the both of which are estimated to have been within the C.G. range (the Maximum Landing Weight: 2,500 lb, the C.G. range: 15 to 20 in).</p> <p>(3) The history of the maintenance of the aircraft:</p>
Date	Maintenance work regarding the aircraft and the tailwheel (excerpt)
August 4, 1999	Replaced the tailwheel to MODEL 3200-00 manufactured by Scott Aviation Corporation at United State of America.
March 6, 2001	Federal Aviation Administration issued the export certificate of airworthiness.
September 7, 2004	Japan Civil Aviation Bureau issued the airworthiness certificate. There were no detailed materials regarding standards of the tailwheel parts and execution of maintenance such as maintenance manuals, parts catalogues and drawings.
Unknown	According to the statement of the maintenance technician in charge of the company, the company confirmed the standards and size of the bolt, nut and washers connecting the tailwheel bracket assembly with the tail spring by visual inspections and actual measurements, and replaced them with the equivalent parts. Additionally, the maintenance manual of the aircraft did not describe any stipulation regarding the replacement intervals of the bolt,

		nut, washers and others, and the maintenance records did not have any entry at the time of the replacement.
	November 13 to 19, 2014	According to the statement of the maintenance technician in charge of the company, the company performed maintenance for an airworthiness certificate, and it confirmed the shaved dent around the bolt hole at the bolt head side of the tailwheel bracket assembly, and the curvature and crimping marks onto the washers. Only the bolt was replaced. The washers and the nut were not replaced.
	November 21 to 29, 2015	According to the statement of the maintenance technician in charge of the company, the company performed maintenance for an airworthiness certificate. It found the same tendency of the shaved dent around the bolt hole at the bolt head side of the tailwheel bracket assembly, the multiple crimping marks on the washer, the decreases in its thickness and the curbing along the shaved dent, comparing to the conditions at the periodic maintenance on November, 2014. However, the company judged that those parts did not require the replacements. Furthermore, because any anomaly was not found on the bolt, it stayed on to be use.
2.6 Meteorological Information		According to the statement of the captain, the windsock which he saw at the time of the final approach were estimated to be about 250 degrees at 14 kt.
2.7 Additional Information	(1)	Criteria relating to the maintenance work AC43.13-1B ^{*1} (hereinafter referred to as "the criteria for

^{*1} U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION Flight Standard Service Regulatory Support Division, "ACCEPTABLE METHODS, TECHNIQUES, AND PRACTICES – AIRCRAFT INSPECTION AND REPAIR", AC 43, 13-1B, September 8, 1998. pp.7-297

the aircraft maintenance work") issued by Federal Aviation Administration, which describes a detailed work criteria regarding the inspection and maintenance of an aircraft, has a description that in general, a grip length equals to the thickness of a members, when the bolt grip is slightly longer, a washers could be used under the nut and bolt head, but the total thickness of the washers should be 3.175 mm (1/8 in) or less.

On the other hand, the grip length of the bolt being in use to connect the tailwheel bracket assembly to the tail spring was longer by 4.763 mm (3/16 in) than the tightening members and using three sheets of 1.588 mm (1/16 in) thick washers (one washer on the bolt head side and two on the tail spring side of the airframe), the total thickness was thicker by 1.588 mm than the value of the criteria for the aircraft maintenance work.

(2) Standard for tailwheel connecting bolt

The company did not obtain a maintenance manual, parts catalogue and drawings applicable to the aircraft. Because the same type of the tailwheel installed to the aircraft was not manufactured anymore and the company which designed and manufactured the tailwheel did not exist, therefore, these materials are hard to obtain. On the other hand, if replacing to the tailwheel adopted by an aircraft manufacturer as a standard or the interchangeable component manufactured by the company other than Scott Aviation Corporation and approved by Federation of Aviation Administration, the installation manual, a part catalogue and drawings could be obtained.

(See Appendix 2: Interchangeable tailwheel (reference))

(3) Fracture face investigation of the bolt

The cause of fracture of the bolt was a fatigue fracture originating in the loosening of the bolt, based on the material analysis and the fracture surface observation of the fractured bolt done by National Institute for Materials Science by our request.

(See Appendix 3 Fracture Surface Investigation of the bolt)

3 ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilot	None
3.3 Involvement of Aircraft	Yes
3.4 Analysis of Findings	<p>(1) Detachment of the tailwheel</p> <p>Regarding the inability to continue the operation of the aircraft, it is certain that because the tailwheel from the airframe was detached and fallen. In addition, it is highly probable that based on the investigating result of the bolt fracture surface, the reason for the tailwheel bracket assembly to slip from the tail spring was fractured by generation of the fatigue fracture below the neck of the bolt head due to the loosening of the bolt which connected the tailwheel bracket assembly to the tail spring of the airframe.</p> <p>It is probable that the loosening of the bolt was generated because the load of vibration during taxiing and the impacting load at landing increased the curvature of the washer and decreased the thickness of it at the bolt head side where the bolt was tightened at a slightly afloat position due to the pre-existing slight shaved dent on the tailwheel bracket assembly, because the tightening torque was not enough, or because the space between the bolt head and the washer enlarged due to simultaneous occurrences of these factors.</p> <p>On other hand, it is somewhat likely that the shaved dent of the tailwheel bracket assembly was gradually created by the generation of the friction with the washer due to the multiple tightening of the bolt, insufficient torque to tighten the bolt and nut, and impacting load at landing or the vibration during the taxiing.</p> <p>(2) Maintenance work</p> <p>It is probable that the maintenance work was required to follow the maintenance manual, a part catalogue, drawings and likes which should be obtained corresponding to the specification</p>

	<p>of the tailwheel.</p> <p>It is probable that when the company had confirmed the shaved dent on the tailwheel bracket assembly, the curvature on the washer of the bolt head side and the decrease of the thickness at the time to implement the maintenance work, the tailwheel bracket assembly and the washer should be required to replace. It is probable that the bolt should be inspected in details and then it was required to replace.</p>
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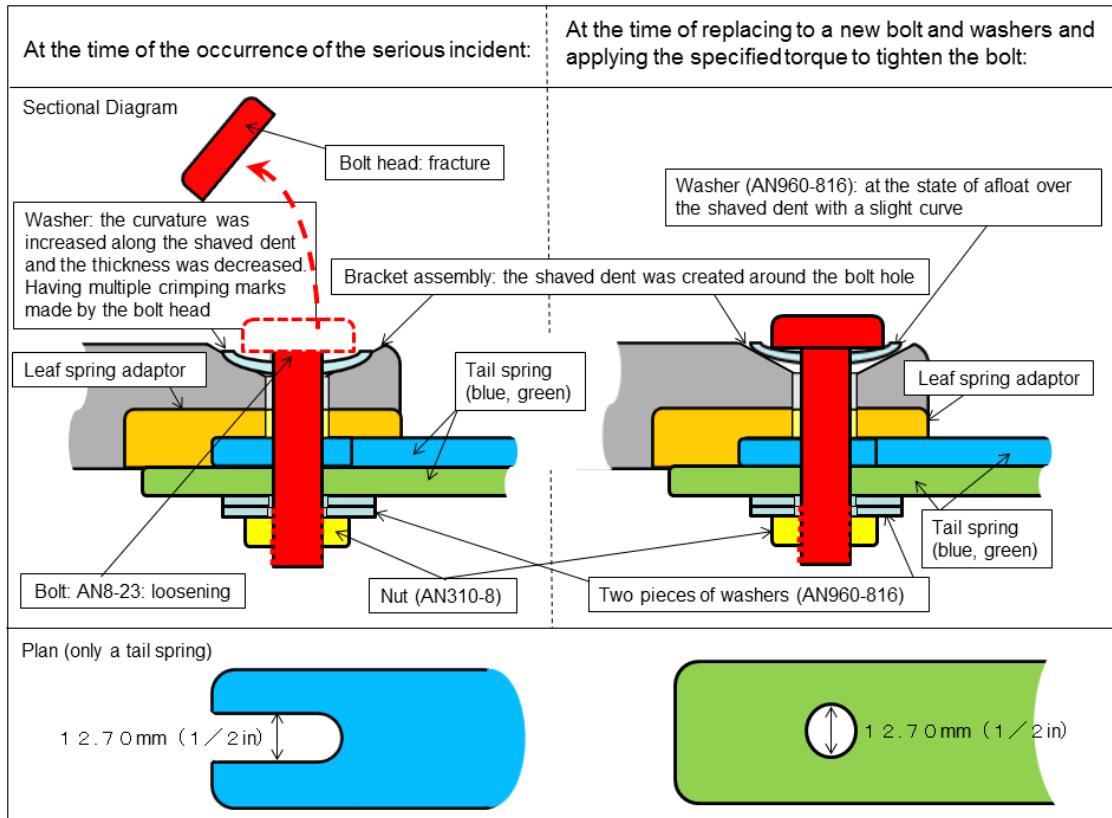
4 PROBABLE CAUSES

At this serious incident, it is certain that the aircraft could not continue the operation because during its taxiing after the landing, it dropped the tailwheel from the tail spring of the airframe.

Regarding the falling of the tailwheel from the airframe tail spring, it is highly probable that because the head part of the bolt connecting the tailwheel bracket assembly had a fatigue fracture generated and was fractured.

Regarding the breakage due to the generation of fatigue fracture at the bolt head part, it is certain that it involved not to implement a proper maintenance work following the technical materials such as maintenance manual, parts catalogue and drawings applicable to the specification of the tailwheel.

Appendix 1 Diagram to Install a Tailwheel



Appendix 2 Interchangeable Tailwheel (reference)

After the serious incident, the parts being in use to connect the tailwheel, manufactured by other than Scott Aviation Corporation and approved as an interchangeable parts by FAA, is a combination of one AN7-20 bolt, one sheet of 3/8 in USS^{*2} FLAT washer, one sheet of NAS^{*3} 1149F0763P (AN960-716 interchangeable) washer, and one MS^{*4} 21044N7 (AN365-720 interchangeable) nut with a cylinder shaped tailwheel bolt spacer to match the inner diameter of the bolt hole of the tailwheel bracket assembly.

On the other hand, the tailwheel parts of the aircraft at the time of the serious incident occurred did not use a tailwheel spacer, but using one AN^{*5} 8-23 bolt (comparing to the AN7-20 bolt, the diameter is bigger by 1/16 in, the length is longer by 3.8 in and the grip length is longer by 1/4 in), three sheets of AN960-816 washer and one AN310-8 nut to connect.

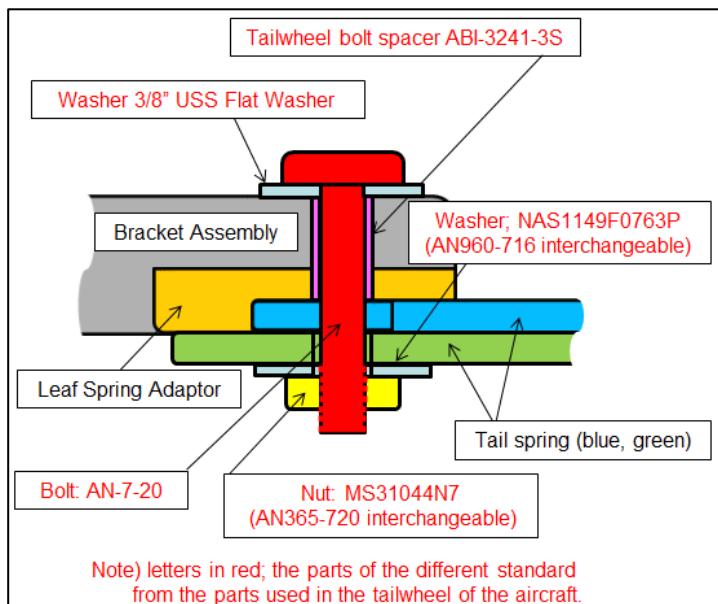


Figure 1 Interchangeable Tailwheel Manufactured by Other than Scott Aviation Corporation and approved by FAA

^{*2} United States Standard

^{*3} National Aerospace Standard

^{*4} Military Standard

^{*5} Air Force and Navy Aeronautical Standard

Appendix 3 Fracture Surface Investigation of the bolt

1. Cause of the bolt fracture

- (1) As the result of having observed the metal structure of the fractured bolt, the chemical components are within the range corresponding to the low-alloy steels of JIS-SNCM220.
- (2) As the result of having observed the fracture surface, it is probable that the intergranular fractured surface which is a characteristic of a delayed fracture could not be observed, the striation patterns (a regular stripe pattern) which is a characteristic of a fatigue fracture could be observed, multiple level differences near the surface which is a characteristic of the fatigue fracture surface at the stress concentration portion was observed, and a characteristic relatively fine pattern on the fracture surface near a fatigue crack initiating point was observed, therefore, this fracture of the bolt was occurred due to the fatigue.
- (3) Based on the deformation of washer and the abrasion status of the bolt side, it is somewhat likely that the bolt was loosened from the time of the use.
- (4) It is probable that the cause of the fracture of this bolt was a fatigue fracture due to loosening of the bolt.

2. Analyzing the mechanism leading to fatigue fracture

- (1) The curvature of the washer was increased and the thickness of it was decreased during the use.
- (2) Uneven hits were generated to the bolt, because the bolt axial tension was released and resulted in the bolt loosened status due to the increase in the washer curvature and decrease in thickness.
- (3) A bending moment was generated to the tailwheel assembly.

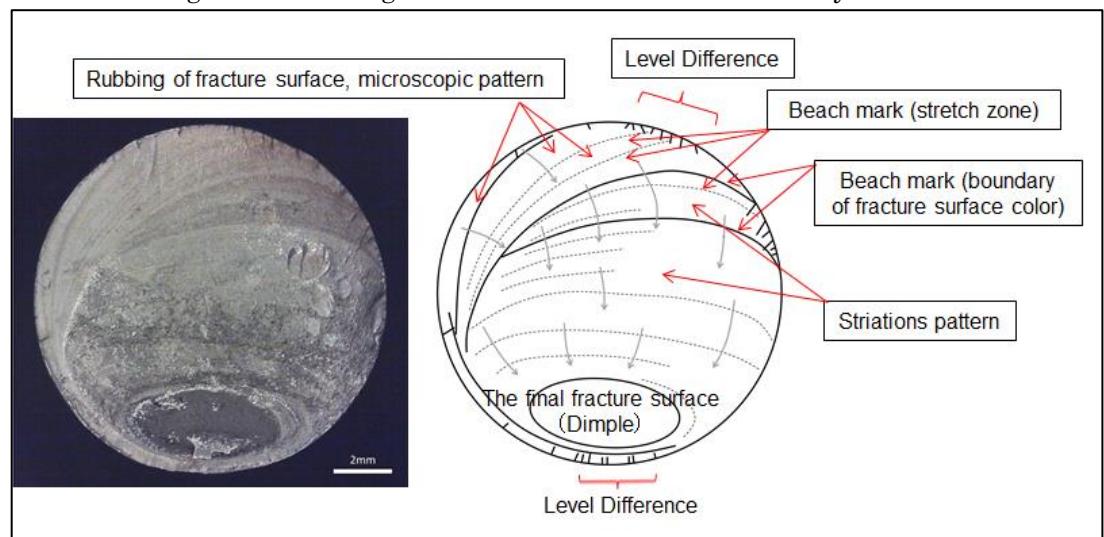


Figure 2 Fracture Surface Investigation of the Bolt

- (4) The crack was generated due to high-cycle fatigue (about 10^4 to 10^6 times) because excessive stress exceeding the fatigue limit had concentrated onto the neck.
- (5) The repetition times with only number of the takeoff and landing are insufficient to lead to the high-cycle fatigue, because the times to takeoff and landing of the aircraft with the bolt are only 1,400 times, therefore, mostly the stress due to vibration at the taxiing at takeoff and landing developed the fatigue crack. In addition, the plastic blunting of fatigue crack point due to the excessive load slightly stronger than normal at the time of landing created a stretch zone (beach mark), regularly.
- (6) The acting stress on remaining cross section area which is exceeding the tensile strength of the materials created a ductile fracture and a dimple to break and drop the bolt.

3. An observation situation of the bolt side surface

The photo of Figure 3 shows the elevating view by pasting images taken on all around bolt by a microscope together. For a new bolt, it is normally metal plated and has the yellow appearance.

However, the region of A to C of the bolt connecting the tailwheel has becomes black due to the adhered substances or peeling of the plating. Besides, it is probable that the D region has no traces of plating, scars in the circumferential direction and more sever abrasion comparing to the regions of A to C. Moreover, within the C region, some area have more sever abrasion than some places, the some area with severe abrasion has wide scars to the longitudinal direction.

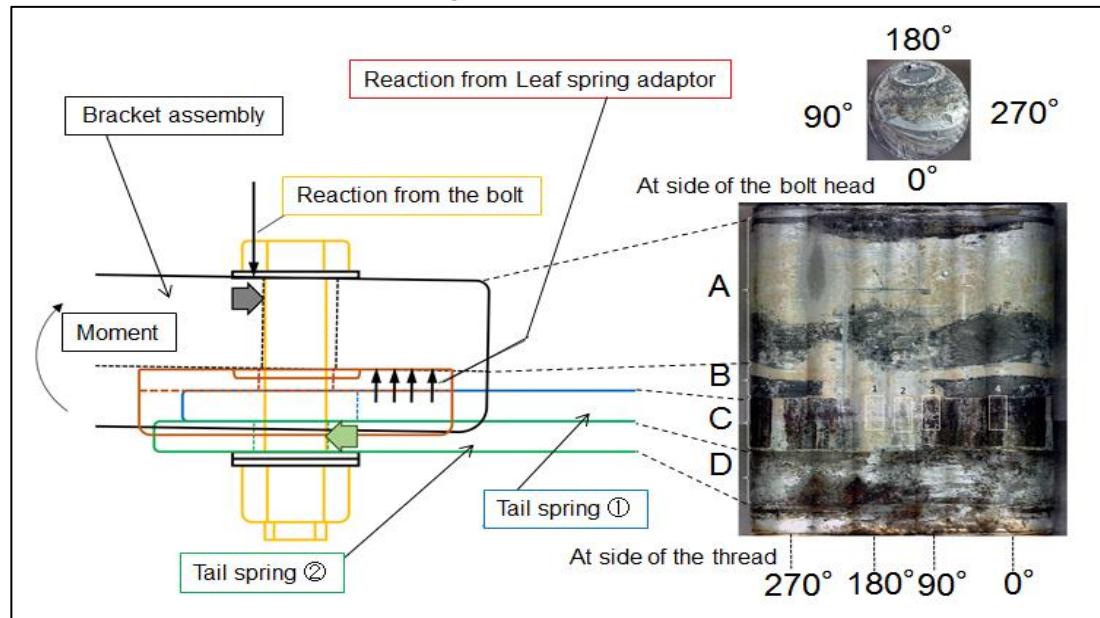


Figure 3 Stress when the Bolt at Loose and the Side View of the Bolt