AI2013-4

AIRCRAFT SERIOUS INCIDENT

INVESTIGATION REPORT

FUJI GLIDER CLUB
J A 1 0 9 B

October 25, 2013

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.

Norihiro Goto
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

RUNNING OFF THE SIDE OF RUNWAY AFTER LANDING
FUJI GLIDER CLUB
GROB G109B (MOTOR GLIDER, 2 SIDE BY SIDE), JA109B
FUJIKAWA GLIDER STRIP,
SHIZUOKA CITY, SHIZUOKA PREFECTURE
AT 11:19 JST, APRIL 7, 2012

September 27, 2013
Adopted by the Japan Transport Safety Board

Synopsis

Summary of the Serious Incident

On April 7 (Saturday), 2012, at 11:10 Japan Standard Time, a Grob G109B, registered JA109B, operated by the Fuji Glider Club, took off from the Fujikawa Glider Strip for a familiarization flight with the captain and one passenger on board. Subsequently, as it landed at the gliding field at 11:19 as part of the continuous touch-and-go training, the glider veered to the right and went off the runway, becoming immobilized.

The glider sustained minor damage. No one was injured.

Probable Causes

It this serious incident the glider's right main landing gear was damaged upon landing followed by right veering off the runway and the glider eventually collapsed.

It is highly probable that the right main landing gear's displacement occurred as the threads of the inboard gear mount nuts gave way and slipped out of the bolts, leaving the outboard mount to support the gear followed by the forward outboard nut failure due to the similar reason, causing the gear swivel aft on the aft mount bolt.

It is highly probable that the nuts of lower strength not being the parts specified by the manufacturer sustained damage to the threads, as the tensile load beyond the tensile strength was applied upon touchdown.

It could not be ascertained when and how these nuts were installed on the glider.

This report uses the following abbreviation:

DIN: Deutsche Industrie Normen (Industry Standard of Germany)

Conversion Table

1 ft： 0.3048 m
1 kt: 1.852 km/h (0.5144 m/s)

1. PROCESS AND PROGRESS OF AIRCRAFT SERIOUS INCIDENT INVESTIGATION

1.1 Summary of the Serious Incident

The occurrence covered by this report falls under the category of "Deviation from a runway (limited to when an aircraft is disabled to perform taxiing)" as stipulated in Clause 3, Article 166-4 of the Civil Aeronautics Regulations of Japan, and is classified as a serious incident.

On April 7 (Saturday), 2012, at 11:10 Japan Standard Time(JST ; unless otherwise stated all times in JST [UTC+9h]), a Grob G109B, registered JA109B, operated by the Fuji Glider Club, took off from the Fujikawa Glider Strip for a familiarization flight with the captain and one passenger on board. Subsequently, as it landed at the gliding field at 11:19 as part of the continuous touch-and-go training, the glider veered to the right and went off the runway, becoming immobilized.

The glider sustained minor damage. No one was injured.

1.2 Outline of the Serious Incident Investigation

1.2.1 Investigation Organization

On April 7, 2012, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and another investigator to investigate this serious incident.

1.2.2 Outsourced Investigation

As part of the serious incident investigation, material analysis of the mounting bolts and nuts for the main landing gear of the glider and other inspections were outsourced to the National Institute for Materials Science.

1.2.3 Representative of the Relevant State

The occurrence of the serious incident was notified to Federal Republic of Germany, as the State of Design and Manufacture of the aircraft, the State did not designate an accredited representative.

1.2.4 Implementation of the Investigation

April 8, 2012	Interviews and glider examination
May 9, 2012	Airflame examination
May 28 – December 7, 2012	Material analysis of the mounting bolts and nuts for the main landing gears and other inspections (by the National Institute for Materials Science)

1.2.5 Provision of Factual Information

On April 19, 2012, the JTSB provided the Civil Aviation Bureau (JCAB) of the Ministry of Land, Infrastructure, Transport and Tourism with factual information regarding the nuts used on the main landing gear of the glider.

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

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

1.2.7 Comments from the Relevant State

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

2. FACTUAL INFORMATION

2.1 History of the Flight

On April 7, 2012, at 11:10, a Grob G109B, registered JA109B, operated by the Fuji Glider Club (hereafter referred to as "the Club"), took off from the Fujikawa Glider Strip (hereafter referred to as "the Glider Strip") for a familiarization flight with the captain and one passenger on board.

The history of the flight up to the time of the serious incident is summarized below, based on the statements of the captain, the passenger and a witness.

(1) Captain

The captain was on the day third flight (the day first flight as a captain), taking off at 11:10 for continuous touch-and-go training. There was no particular abnormality with the takeoff. After flying a traffic pattern at 800 ft as he normally did, he set the propeller pitch to climb and the engine to idle before initiating an approach to runway 18. The day wind was 200° at 12 kts. As he felt that the wind was becoming slightly stronger, he entered the path a little higher than he normally would and kept the airspeed at 120 km/h instead of the standard speed of 115 km/h. As he began the landing maneuvers, he felt that the glider might be slightly higher than it should be. However, he thought that he would be able to land if he gradually lowered the Glider as he normally did while setting the touchdown point slightly farther away. He continued to control the glider the way he normally did until the flare, during which he made an early rotation[*1], the glider subsequently sank rapidly before making a touchdown. He felt that the touchdown was slightly bumpier than usual; however, it was not in any way a "thump". The glider did not bounce, either. The glider was in a horizontal attitude when it made the touchdown.

[*1] In an early rotation, the control column is pulled while the glider is still flying too high

Immediately after the touchdown, the glider tilted slightly to the right and the tips of the propeller blades hit the runway, breaking up with pieces flying. While he tried to steer the glider using the ladder, the glider veered to the right and went off the runway about 70 meters from the touchdown point. The glider then slowly turned right and came to a halt on the grass.

(2) Passenger (Club instructor)

The passenger checked the glider before departure and found no abnormality with the engine or other components. The wind was 200°–210° at 12 kts (15 kts in gust) and was gradually becoming stronger than earlier in the morning.

As the approach path of the glider was higher than normal, the passenger advised the captain to that effect. At that time, the airbrake was approximately half extended. The passenger felt that the glider was aiming at a point about 100 meters beyond the fixed distance marking. Subsequently, the captain initiated a flare while the glider was still slightly too high. Soon after the flare, the glider sank rapidly by about three meters to the ground keeping the same pitch angle (as if it were a descending elevator). The impact of the touchdown was not as severe as anticipated. The glider landed at 11:19. Upon touchdown, the glider began to tilt and slowly veered to the right as it slowed down. After moving along for a while, the glider entered the grass area, made a tight right turn about 150° before coming to a halt.

(3) Witness (Club instructor)

The witness inspected the glider and made an engine run-up before the day first and second flights. The Club holds sessions once every month and does not offer any serious in-depth training programs. On the day of the serious incident, each attending club member had a familiarization flight for about 30 minutes including continuous touch-and-goes. During the two flights immediately before the serious incident, there was no abnormality with the glider.

The witness, who had been observing the glider from the short final, felt that the flight path was slightly higher than normal although it appeared stable. Nonetheless, the witness felt that the glider could still land and stop within the runway. The flare was also made while the glider was still slightly higher than it should be. After slightly raising its nose and entering a level flight, the glider still did not start a smooth descent, which made the witness think that it would be making a go-around. Right at that moment, though, the witness saw the glider sink abruptly to the ground. Normally, when a glider stalls, it takes a nose-down attitude. The glider, however, appeared to be sinking while keeping a horizontal attitude. There was almost no sound. After the touchdown, the glider veered to the right and went off the runway.

The serious incident occurred at 11:19 on April 7, 2012, on around halfway down the Gliding Field's runway (Latitude 35°07'17"N, Longitude 138°37'52"E).

(See Figure 1 – Estimated Flight Path, Photo 1 – Serious Incident Glider and Photo 2 – Marks Left on the Runway.)

2.2 Injuries to Persons

No one was injured.

2.3 Damage to the Aircraft

2.3.1 Extent of Damage

Slightly damaged

2.3.2 Damage to the Glider Components

Right main landing gear mount:Damaged

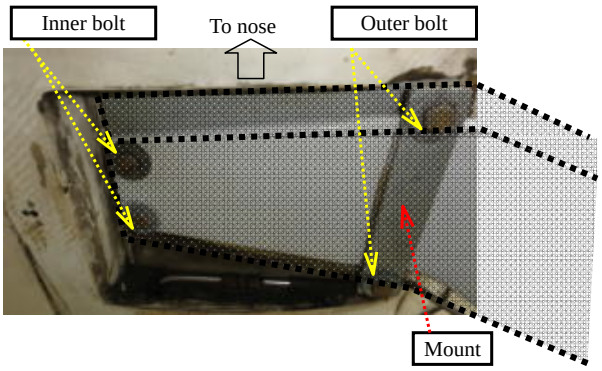
Brake discs on left and right main landing gear wheels: Damaged

Propeller: Damaged

The left and right main landing gears of the glider were each mounted on the airframe using, as shown in the right photo, four bolts, four outboard washers, four inboard washers, two spacers, four nuts (each with a locking system) and a metal mounting plate. (The photo shows the left main landing gear, which was not damaged in the serious incident.)

The two inboard nuts and the front outboard nut from the right main landing gear were found to have come off and fallen inside the airframe with their threads damaged.

(See Photo 1 – Serious Incident Glider.)



Left main landing gear

Left main landing gear mount

Damaged nut

2.4 Other Damage

None

2.5 Personnel Information

(1) Captain Male, Age 40

Private pilot certificate (Glider) April 12, 2000

Type rating for motor glider April 12, 2000

Class 2 aviation medical certificate

Validity	June 30, 2012
Total flight time (Glider)	116 h 50 min
Flight time in the last 30 days	0 h 00 min
Total flight time on the type of glider	12 h 15 min
Flight time in the last 30 days	0 h 00 min

(2) Passenger Male, Age 59

Commercial pilot certificate (Glider)	July 28, 1976
Type rating for motor glider	November 1, 1973
Flight instructor certificate (Glider)	October 26, 1974
Class 1 aviation medical certificate	
Validity	May 14, 2012
Total flight time (Glider)	2,501 h 28 min
Flight time in the last 30 days	0 h 00 min
Total flight time on the type of glider	53 h 37 min
Flight time in the last 30 days	0 h 00 min

2.6 Aircraft Information

2.6.1 Glider

Type	Grob G109B
Serial number	6246
Date of manufacture	February 20, 1984
Certificate of airworthiness	11-33-15
Validity	June 2, 2012
Category of airworthiness	Motor Glider, Utility (U)
Total flight time	5,623 h 58 min
Flight time since last periodical check (50-hour check on March 3, 2012)	9 h 45 min

(See Figure 2 – Three-Angle View of Grob G109B.)

2.6.2 Weight and Balance

When the serious incident occurred, the weight of the glider is estimated to have been 801 kg, and its position of the center of gravity is estimated to have been 330 mm aft of the reference point, both of which are estimated to have been within the allowable range (maximum takeoff weight of 850 kg, and 271–427 mm for the center of gravity range corresponding to the weight at the time of the serious incident).

2.7 Meteorological Information

Weather observations by the Fuji automated weather station, located about 7.6 km north-northeast of the site of the serious incident, at around the time of the serious incident

are as follows:

11:20 Wind direction: south-southeast, Average wind velocity: 4.3 m/s,
Wind direction: south, Maximum instantaneous wind velocity: 7.2 m/s,
Temperature: 12.6°C, Precipitation: 0 mm, Sunshine hours: 60 min

Wind direction at the site was northwesterly at around 07:00 in the morning, which gradually shifted to southerly, and the serious incident occurred in prevailing southerly wind. Wind velocity gradually increased toward noon, after which the maximum average wind velocity and the maximum instantaneous wind velocity reached 5.7 m/s and 10.1 m/s, respectively.

According to the statement of the captain, based on the appearance of the windsock, the wind direction and velocity at the time of takeoff were estimated to be around 200° and 12 kt, respectively.

2.8 Information on the Serious Incident Site

2.8.1 Glider Strip and Its Vicinity

The Glider Strip is located northeast of the Shizuoka City, on a reverbed the right bank near the mouth of the Fujikawa River. The runway is 850 meters long and 30 meters wide and its headings are 18/36. Its elevation is six meters. Fujikawa Flight Service, an aeronautical station for common traffic advisory is also located there. On the day of the serious incident, the station was closed; accordingly, traffic information and other subjects were broadcasted by one-way transmission.

(See Figure 1 – Estimated Flight Path.)

2.8.2 Serious Incident Site

Two fine scratch marks were found extending near the runway centerline, starting about 145 meters north of the runway center marking towards the spot where the glider came to a halt. One of the scratch marks, made by the right main landing gear, was found to extend about three meters before curving inboard. The mark was joined with a tire mark, and then the amalgamated tire mark continued intermittently down to the runway border with the grass. The other scratch mark, made by the left main landing gear extend about seven meters, and then replaced by a tire mark, which continued down to the grass. Between the two scratch marks, there were three propeller strikes: ICAO Investigation Manual Pat III about 70 cm apart made by the propeller blades. On the grass were tire marks made by the two main wheels and the tail wheel, extending intermittently down to where the glider came to a halt.

The glider was found lying on the ground, with the nose pointing towards 325° and the right main landing gear swiveled around 90° aft on one remaining mounting bolt with the other three mounting bolts missing.

(See Figure 1 – Estimated Flight Path, Photo 1 – Serious Incident Glider and Photo 2 –

Marks Left on the Runway.)

2.9 Tests and Research for Fact-Finding

2.9.1 Specifications for the Bolts and Nuts of the Main Landing Gear

According to the manufacturer of the glider, the bolts and nuts used for mounting the main landing gear must meet the Industry Standard of Germany (DIN), the State of Design and Manufacture of the glider. The information revealed that the nuts used on the glider have the specified pitch but other dimensions of these nuts are clearly different from those specified by the manufacturer.

2.9.2 Detailed Inspection of the Bolts and Nuts of the Right Main Landing Gear

The bolts and nuts used on the glider for mounting the right main landing gear to the airframe (hereafter referred to as "the Removed Parts") were sent to the National Institute for Materials Science for visual inspection, chemical composition analysis, structure observation, hardness measurement, surface analysis, and fracture surface analysis. The findings were then compared with the bolts and nuts specified by the manufacturer of the glider (hereafter referred to as "the Specified Parts"). The results are summarized as below:

(1) Bolts

The Removed Parts are equivalent to the Specified Parts on all inspection items. The threads have no major deformation or other damage.

(2) Nuts

The Removed Parts were shown to have the following differences from the Specified Parts.

a) Visual inspection

The dimensions of the Removed Parts are obviously different from those of the Specified Parts, except the pitch, which conforms to the specification.

Removed Parts: Width across flats: around 16.8 mm, Width across corners of hexagon: around 19.1 mm, Pitch: 1.494 mm

Specified Parts: Width across flats: 13.98 mm, Width across corners of hexagon: 15.90 mm, Pitch: 1.494 mm

b) Chemical composition analysis

The proportion of more than one element of the Removed Parts is less than that of the Specified Parts.

Elemental component (mass %)

Removed Parts: C: 0.06 - 0.10, Si: 0.01, Mn: 0.36 - 0.48, S: 0.009 - 0.014

Specified Parts: C: 0.30 - 0.33, Si: 0.10 - 0.11, Mn: 1.42, S: 0.100 - 0.110

c) Structure observation

The structure of the Removed Parts is different from that of the Specified Parts.

The Removed Parts are of a ferritic-pearlitic structure while the Specified Parts are of a tempered martensitic structure.

d) Hardness measurement

The Removed Parts have only about 75% of the hardness of the Specified Parts.

Vickers hardness (HV):

Removed Parts: Average HV219

Specified Parts: Average HV290

e) Surface analysis

The Removed Parts have a surface treatment different from that of the Specified Parts.

Removed Parts: Galvanization

Specified Parts: Cadmium plating

f) Fractographic study

The threads of the three nuts that had come off are heavily damaged, with portions attached onto the threads of the mating bolts. Some areas of the fracture surface of the nuts have dimples[*2].

(3) Comments from the National Institute for Materials Science

- The Removed Parts (nuts) have the same pitch as that of the Specified Parts (nuts). The nut that had not come off has no major damage to the threads. In addition, the contact surfaces of the nuts have only slight damage. Based on these, it is unlikely that, before coming off, the nuts had sustained heavy damage to the threads from overtightening or vibration.
- Tensile strength is proportional to hardness; therefore, the fact that the removed nuts have lower hardness than the specified nuts means that they have lower tensile strength, which can be a cause of the loosening of the nuts.

2.10 Additional Information

2.10.1 Maintenance History

The glider was manufactured in Germany in February 1984 and used in Germany until it was exported to Japan as a used glider in March 2010. Following necessary inspection and maintenance, the glider received a certificate of airworthiness. Since then, it had been inspected and maintained at appropriate intervals. During these inspection and maintenance operations, however, the bolts and nuts were checked only for looseness and cracks, and not for specifications and other details, as these were not required. These inspections and maintenance operations did not include procedures that required the removal of the bolts and nuts. The service log available in Germany had entries that required the removal of the main landing gears, but did not appear to include any records

*2 "Dimples" can be extensively observed on a surface that has sheared off violently.

that suggested replacement of the nuts.

2.10.2 Flight Manual

The flight manual of the glider carries the procedures for approach and landing as follows:

Chapter 4 Normal operation

4-13 Approach

Before initiating an approach, set the propeller to CLIMB.

1. Engine speed	*1,400 rpm (Airspeed 110 km/h, 59.4 kts)*
2. Propeller control knob	*Set to CLIMB before initiating an approach*
3. Throttle	*Retard*
4. Approach speed	*115 km/h (62 kts)*
	Yellow triangular mark on the speed indicator
	(In rough air, increase speed slightly.)
5. Auxiliary fuel pump	*ON*
6. Air brakes	*Use as required*
	(Effective in steep-angle approach)

(Omitted)

4-14 Landing

1. Airspeed	*Reduce as much as possible.*
2. Control column	*Pull smoothly*
3. Touchdown	*Three-point attitude*
4. Air brakes	*Do not extend fully to prevent hard braking.*

- *After touchdown, pull the control column sufficiently, and fully extend the air brakes. Then, slow down by applying the wheel or toe brakes.*
- *Maintain the desired direction of travel using the tail wheel interlinked with the ladder.*

  The maximum allowable crosswind for takeoff and landing is 20 km/h (11 kts) regardless of dry or wet runway surface.

(Omitted)

3. ANALYSIS

3.1 Crew Qualifications

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

3.2 Airworthiness Certificate

The glider had a valid airworthiness certificate and had been maintained and inspected

as prescribed.

3.3 Meteorological Conditions

According to the observations by the Fuji automated weather station and the statement of the captain, both indicating that the wind at the time of the takeoff of the glider was around 200° at 12 kts; consequently, it is highly probable that at the time of the serious incident southerly wind gradually became stronger and the serious incident occurred in prevailing southerly wind with a varying velocity.

3.4 History of the Flight Up to Running Off the Side of the Runway

3.4.1 Approach and Landing Maneuvers

According to the statement of the captain described in 2.1 (1), it is highly probable that he set the approach speed to 120 km/h, faster than normal, to cope with changeable wind as instructed by the flight manual described in 2.10.2 and that the glider was possible to land safely considering the length of the runway although its flight path was a little higher. It is highly probable that he continued the approach the way he usually did and initiated a flare while the glider was still flying slightly higher than normal. The possible contributing factor for the high flare is rusty flying technique due to: short sessions held only once every month with flying time of only about 30 minutes allocated to each member as stated by the witness in 2.1 (3); more-than-one-month no flying period as described in 2.5; and the first landing attempt of the day when the serious incident occurred.

It is highly probable that the flare reduced the rate of descent and the flight path of the glider became parallel to the ground at higher place, rapidly sinking to the runway. It is highly probable that this was caused by suddenly lost lift due to a reduced airspeed after the flare, and the reduction of the airspeed was affected by fluctuating southerly wind which was becoming stronger as described in 2.7.

3.4.2 Damage to the Right Main Landing Gear

According to the statement of the captain described in 2.1 (1), it is highly probable that the glider made a touchdown in a level attitude, with both main landing gears touching the runway almost at the same time. As described in 2.3.2, the right main landing gear was mounted onto the airframe with two pairs of inboard bolts and nuts, and two pairs of outboard bolts and nuts. Under this circumstance, it is highly probable that the bolts came off after the following process: upon touchdown, the inboard mounting bolts were subjected to great vertical tensile force which was leveraged around the outboard mount; as this force exceeded the tensile strength of the inboard nuts, the threads of the nuts were damaged; and the bolts came off. It is highly probable that this created a condition where sole outboard mount supported the glider, subsequently

subjected to greater-than-permissible tensile strength damaging the threads of the front outboard nut. Therefore, it is highly probable that the right main landing gear swiveled around 90° aft on the remaining aft outboard bolt leaving its scratch marks approaching the airflame center line on the runway.

As described in 2.9.2, in comparison with the Specified Parts, the nuts used on the glider exhibited different material components having lower tensile strength (hardness) by about 25%. According to the dimples observed on the fracture surfaces of the threads of the three nuts, it is highly probable that when the glider landed, the nuts were subjected to instantaneous force greater than their tensile strength to sustain thread damage.

3.4.3 Running Off the Side of Runway

It is highly probable that the scratch marks left on the runway as described in 2.8.2 were made when the bolts on the right main landing gear came off upon touchdown as described in 3.4.2, causing both main landing gears to bend outwards pressing the brake discs against the runway. It is highly probable that the front outboard bolt of the right main landing gear came off, causing the gear to swivel aft with the airframe tilting to the right and that as a result, the tire on the right main landing gear was pressed against the runway, causing the glider to veer to the right. It is highly probable that the glider then ran off the runway and turned right on the grass before coming to a halt.

3.5 Installed Nuts

As described in 2.9, the failed nuts were not the ones specified by the glider manufacturer. While the available service log could not reveal whether or not the nuts had been removed while the glider was in Germany as described in 2.10.1, it is unlikely that the nuts had already sustained damage to the threads from loosening and others, because: even before the touchdown as almost identical bolts and nuts were used on both main landing gears as described in 2.3.2; the witness who had flown the glider immediately before the serious incident flight felt no problem with the glider; and detailed inspection of the failed nut indicated no signs of overtightening or vibration as described in 2.9.2.

3.6 History of Nut Installation

As no maintenance work requiring the removal of the main landing gears was done after it was imported to Japan as described in 2.10.1, it is highly probable that the Removed Parts were installed on the glider between its manufacture and its export to Japan. On the other hand, the JTSB could not ascertain how the Removed Parts had been installed. Although the German maintenance log carried the maintenance work that required the removal of the main landing gears, it neither included any entry indicative of the replacement of the nuts nor other service records suggesting the replacement of the nuts.

3.7 Installation of Parts

When installing aircraft parts, only specified parts must be used. In this serious incident, it is highly probable that the fact that the nuts used were non-specified parts with lower tensile strength as described in 3.4.2, contributed to the occurrence of the serious incident, although it is not clear when and how the parts were installed as described in 3.6. Once installed, the parts such as nuts are not normally checked in subsequent inspections for their legitimacy making it extremely difficult to spot non-manufacturer-specified parts during ordinary maintenance work. Therefore, those who install parts onto the aircraft must be fully aware of the importance of specified parts installation.

4. PROBABLE CAUSE

It is highly probable that this serious incident occurred because the right main landing gear of the glider was damaged upon landing followed by right veering off the runway and the glider eventually collapsed.

It is highly probable that the damage to the right main landing gear occurred as the threads of the inboard gear mount nuts gave way and slipped out of the bolts, leaving the outboard mount to support the gear followed by the forward outboard nut failure due to the similar reason, causing the gear swivel aft on the aft mount bolt.

With regard to the damage to the thread of the nuts, the nuts were not specified ones by the manufacturer and its strength was lower than specified ones; therefore, it is highly probable that the tensile load beyond the tensile strength was applied upon touchdown of the airflame

In addition, it could not be ascertained when and how these nuts were installed on the glider.

Figure 1　Estimated Flight Path

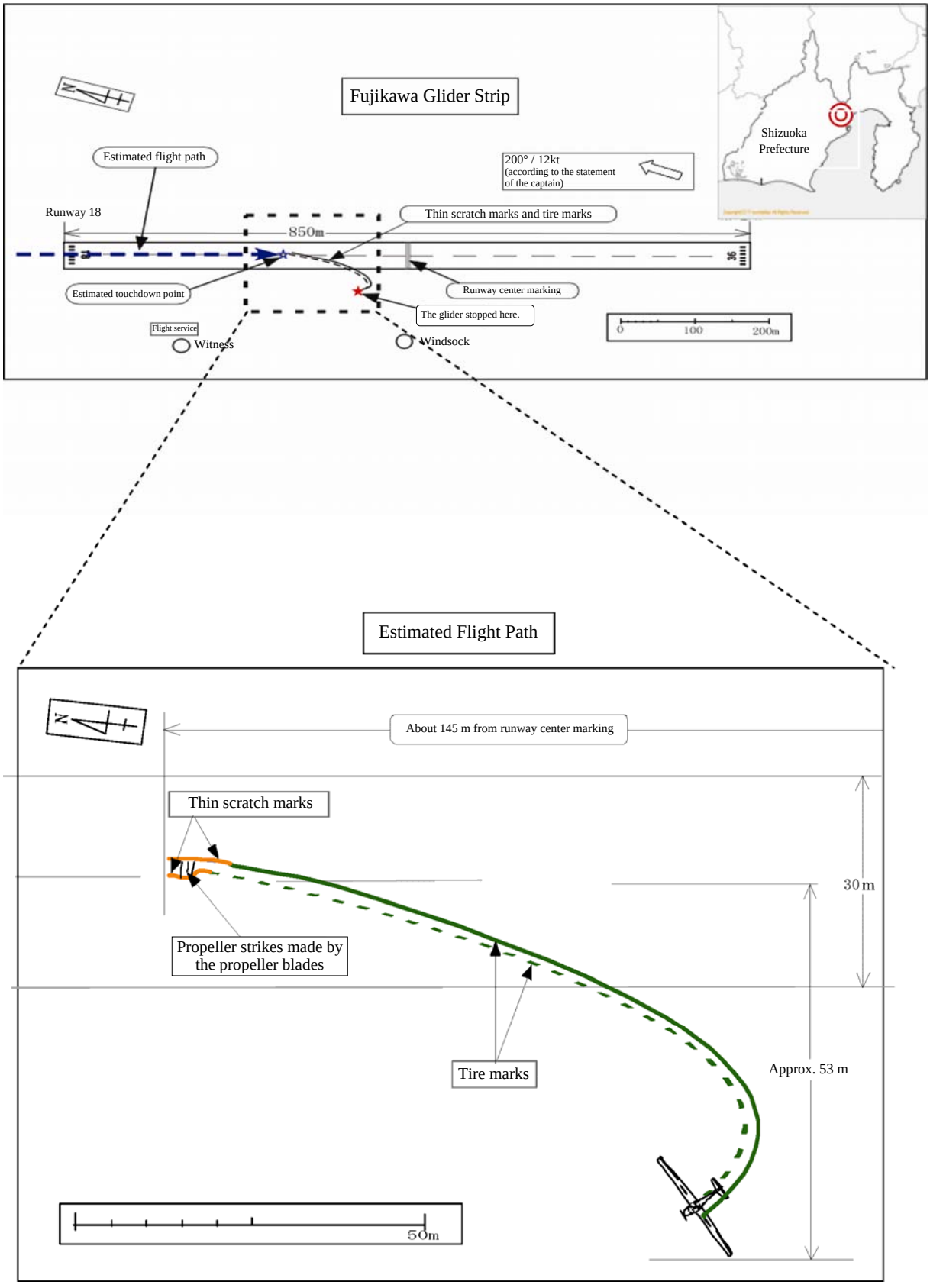


Figure 2　Three-Angle View of Grob G109B

Unit: m

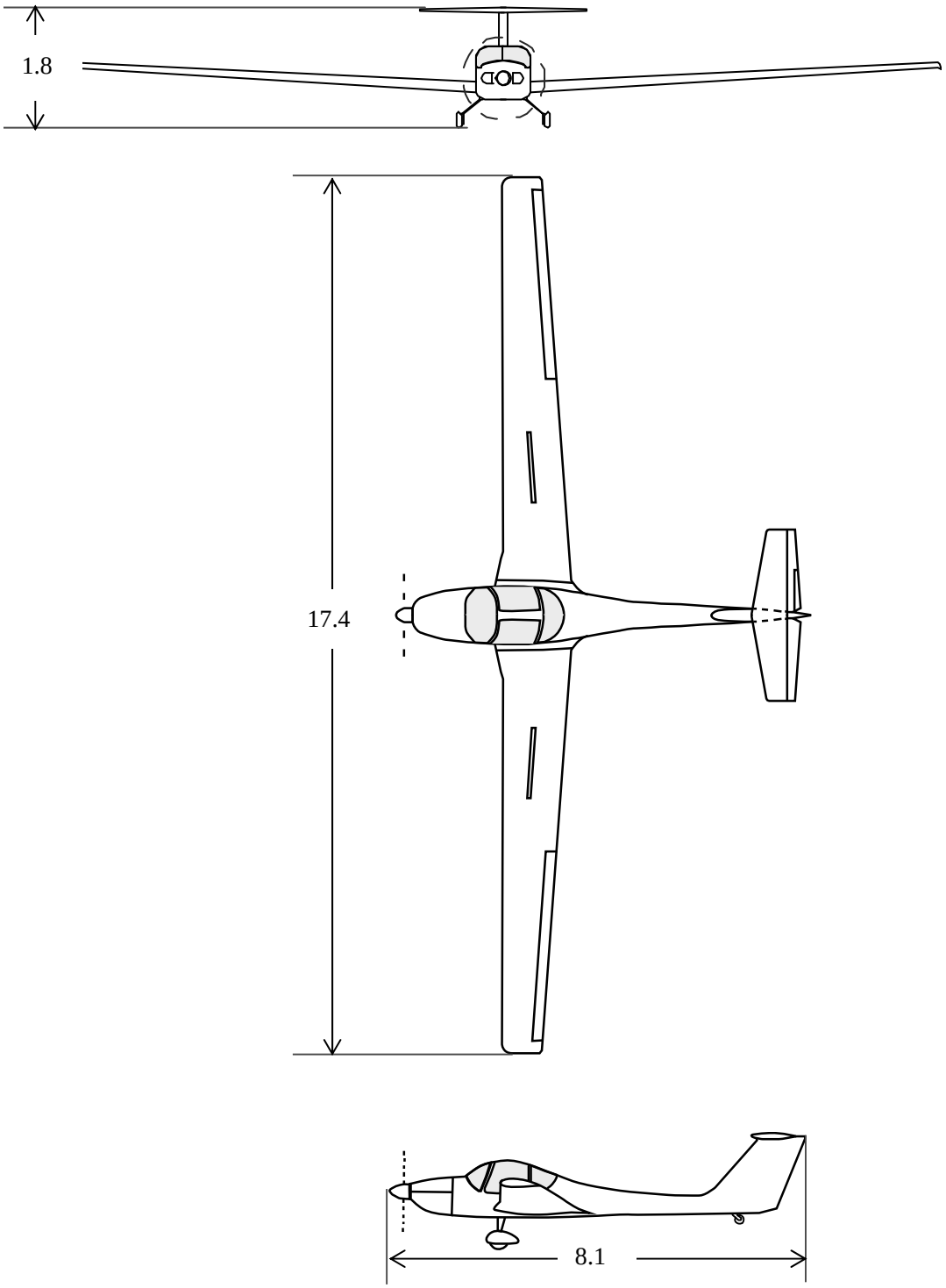


Photo 1　Serious Incident Glider

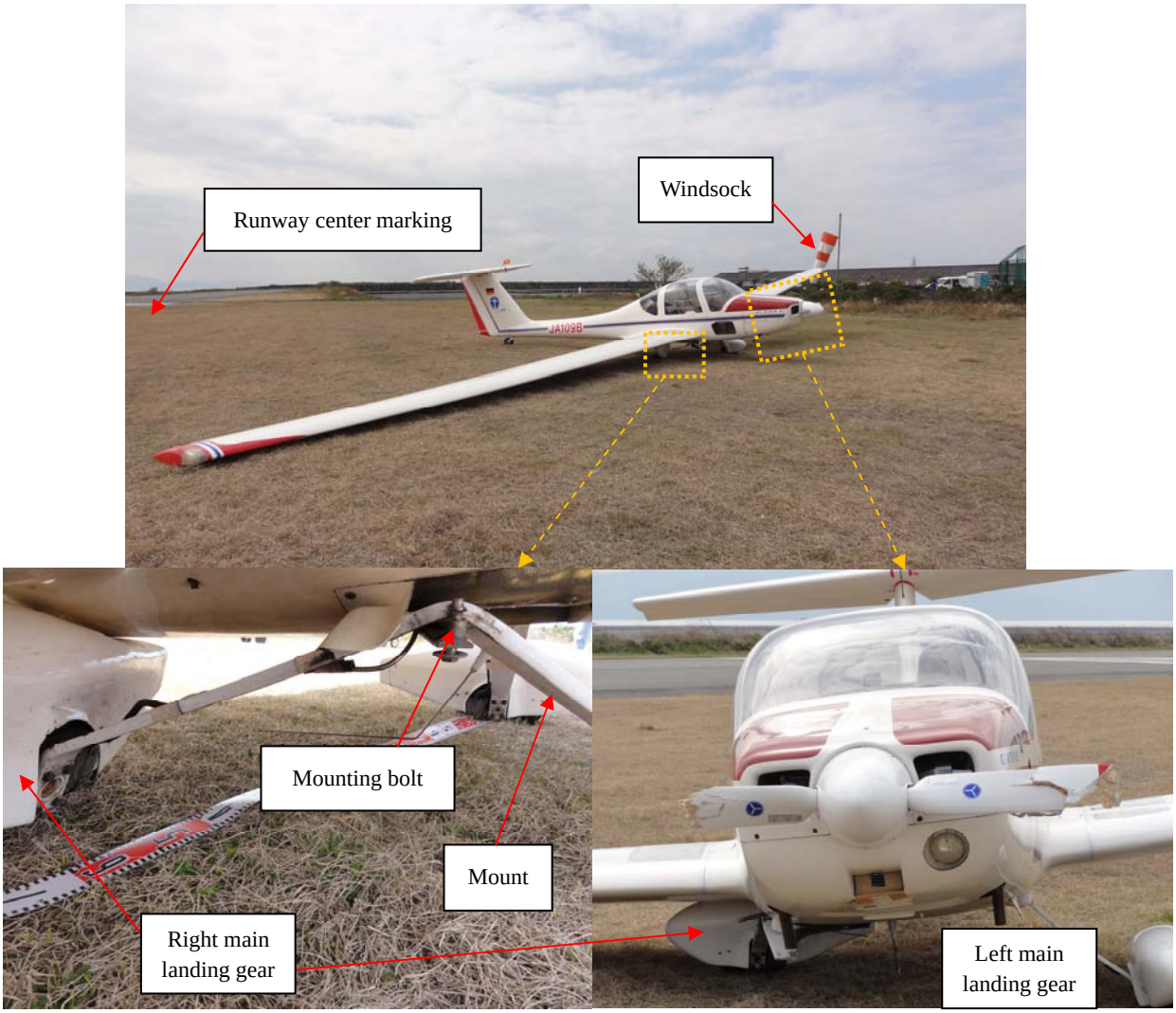


Photo 2　Marks Left on the Runway