

AA2014-7

**AIRCRAFT ACCIDENT
INVESTIGATION REPORT**

PRIVATELY OWNED

J A 2 3 T N

November 27, 2014



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 determine the causes of an accident and damage incidental to such an accident, thereby preventing future accidents and reducing damage. 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 ACCIDENT INVESTIGATION REPORT

AIRFRAME DAMAGE DURING FORCED LANDING
PRIVATELY OWNED
ROBINSON R22 BETA (ROTORCRAFT), JA23TN
ASANAMIHARA, MATSUYAMA CITY,
EHIME PREFECTURE, JAPAN
AROUND 10:04 JST, MARCH 16, 2013

October 24, 2014

Adopted by the Japan Transport Safety Board

Chairman	Norihiro Goto
Member	Shinsuke Endoh
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Yuki Shuto
Member	Keiji Tanaka

SYNOPSIS

<Summary of the Accident>

On Saturday, March 16, 2013, around 09:30 Japan Standard Time (JST: UTC+9hr; unless otherwise stated, all times are indicated in JST on a 24-hour clock), a privately owned Robinson R22 Beta, registered JA23TN, took off from a temporary operation site in Fukuyama City, Hiroshima Prefecture, for a leisure flight en route to Matsuyama Airport. At around 10:04, the aircraft was damaged during a forced landing near Asanamihara, Matsuyama City, Ehime Prefecture, after the captain noticed an abnormality in the engine RPM.

The captain and one passenger were on board the aircraft, and the captain suffered a minor injury.

The aircraft was destroyed, but there was no outbreak of fire.

<Probable Causes>

It is probable that when the engine/rotor RPM increased while cruising to the destination airport, the captain could not deal with the situation, which led him to aim for a bamboo grove to make a forced landing, and that the airframe was damaged at the time.

It is probable that the reason the captain could not deal with the situation is because he decided that the cause of the rotor over-speeding was that the engine was over-speeding and out of control, without confirming the engine/rotor RPM from the indication of the tachometer.

It is somewhat likely that the reason the engine/rotor RPM increased involved the power switch of the alternator being in the off position for some reason and there being no power supply from the alternator, which caused the master battery power to be consumed leading to a lack of the power supply required to operate the governor, which in turn caused the operation of the governor to be suspended. However, because it was not possible to identify when the alternator switch became in the off position, it could not be determined why the RPM increased.

Abbreviations used in this report are as follows:

VFR: visual flight rules

RPM: revolutions per minute

Unit Conversion Table

1 ft: 0.3048 m

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

1 lb: 0.4536 kg

1 lb/ft: 0.1383 kg/m

1 US Gal: 3.7854 ℓ

1 in: 25.4 mm

1. PROCESS AND PROGRESS OF AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident

On Saturday, March 16, 2013, around 9:30 Japan Standard Time (JST: UTC+9hr; unless otherwise stated, all times are indicated in JST on a 24-hour clock), a privately owned Robinson R22 Beta, registered JA23TN, took off from a temporary operation site in Fukuyama City, Hiroshima Prefecture, for a leisure flight en route to Matsuyama Airport. At around 10:04, the aircraft was damaged during a forced landing near Asanamihara, Matsuyama City, Ehime Prefecture, after the captain noticed an abnormality in the engine RPM.

The captain and one passenger were on board the aircraft, and the captain suffered a light injury.

The aircraft was destroyed, but there was no outbreak of fire.

1.2 Outline of the Accident Investigation

1.2.1 Investigation Organization

On March 16, 2013, the Japan Transport Safety Board received an accident notification, and then designated an investigator-in-charge and another investigator to investigate this accident.

1.2.2 Representative of the Relevant State

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

1.2.3 Implementation of the Investigation

March 16 to 18, 2013:	On-site investigation, aircraft examination, and interviews
May 10, 2013:	Investigation of the equipment of the aircraft by the National Transportation Safety Board (NTSB) of the United States of America (the U.S.A)
October 26, 2013:	Electric load analysis by the manufacturer of the master battery equipped in the aircraft
April 15, 2014:	Interviews

1.2.4 Comments from Parties Relevant to the Cause of the Accident

Comments were invited from the parties relevant to the cause of the accident.

1.2.5 Comments from the Relevant State

Comments were invited from the relevant state.

2. FACTUAL INFORMATION

2.1 History of the Flight

On March 16, 2013, a privately owned Robinson R22 Beta, registered JA23TN (hereinafter referred to as “the Aircraft”), took off from Takegahana Temporary Operation Site in Minomicho, Fukuyama City, Hiroshima Prefecture (hereinafter referred to as “Takegahana”) at around 09:30. When flying at an altitude of approximately 1,000 ft and at a speed of approximately 80 kt en route to Matsuyama Airport, the captain decided to give up on continuing the flight as a result of an increase in the engine RPM putting the Aircraft in an abnormal condition, and the Aircraft was subsequently damaged during a forced landing near Asanamihara, Matsuyama City, Ehime Prefecture.

The outline of the flight plan was as follows:

Flight rules: Visual Flight Rules (VFR)

Departure aerodrome: Takegahana

Estimated off-block time: 09:25

Cruising speed: 80 knots

Cruising altitude: VFR

Route: Imabari

Destination aerodrome: Matsuyama Airport

Total estimated elapsed time: 0 hours and 25 minutes

Fuel load expressed in endurance: 2 hours and 00 minutes

Persons on board: 2

The history of the flight up to the accident is summarized as below, according to the statements of the captain and a witness immediately after the accident and the statements by the captain and passenger when they were invited to make comments.

(1) Captain

The captain conducted a pre-flight check as usual at around 9:30, and there were no abnormalities. He confirmed that there were no problems with the switch settings and departed from Takegahana with one passenger for Matsuyama Airport. At that time, the navigation light switch had not been turned on because it was a daytime flight. Subsequently, the captain didn't notice any abnormalities during approximately 30 minutes of flying until reaching near the place where he made a forced landing. The caution light was not lit.

As around 10:04, the captain noticed an abnormality in the engine sound while flying at an altitude of approximately 1,000 ft and at a speed of approximately 80 kt above the area near the forced landing site. The engine and main rotor were rotating at an abnormally high speed, and when the captain looked at the manifold pressure indicator, the indication was abnormally high. He didn't look at the other instruments. Although the collective pitch lever was lowered, the indication of the manifold pressure indicator did not respond.

Since the captain assumed that the RPM governor system*¹ (hereinafter referred to

*1 The "RPM governor system" is a supplementary throttle control system designed to maintain the engine RPM within a range of 101 to 104 percent. This system augments the mechanical throttle control system linked to the throttle grip with an electric motor. This electric motor is designed so that a pilot can easily override the control by manually operating the throttle.

as the “governor”) was broken, he switched the governor off and closed the throttle a bit, and then tried turning the governor switch on and off. However, the captain assumed that there was no obvious change in the engine sound or the indication of the manifold pressure indicator, and that there was no decrease in the engine RPM.

Because the caution light indicating the disengagement of the clutch had not lit, the captain assumed that the engine was over-speeding and out of control. While he was able to control the Aircraft, he felt that the response was oversensitive to operations; for example, the Aircraft had a strong reaction when he applied the rudder just a little. In addition, he heard a loud clang from the engine and thought that the engine would break soon.

The captain thought that he would have to land somewhere, but that it would be impossible to land without destroying the Aircraft. Although there was a mountain in the direction he was traveling in, when he turned the Aircraft to the right, a bamboo grove came into his field of view, and he decided to make a forced landing aiming for the grove.

First, the captain lifted the nose up greatly, reduced the speed, and made a normal approach. He flared the Aircraft at the end, so the speed was low when the Aircraft hit the bamboo trees. He didn’t operate any switches when he made the forced landing, and he just escaped with everything as is.

The captain felt as if only about 10 seconds had passed between the time he noticed engine abnormalities and the forced landing in the bamboo grove. During that time, he thought there was no chance they could survive.

(2) Passenger

While the passenger looked at the instrument board with great interest because that was the second time that she had ridden in a helicopter, the yellow light did not come on while they were flying.

The passenger wondered why the Aircraft did not rise despite the fact that it came close to a mountain. The passenger looked at the expression on the captain’s face and intuitively felt that something was wrong. The passenger noticed that the Aircraft didn’t seem to be going up or down and heard a very loud engine sound. Afterwards, the Aircraft turned to the right and descended into the bamboo grove. When the captain made the forced landing into the bamboo grove, the Aircraft impacted into the bamboo trees three times with a loud sound, and it seemed as if it had entered into a tunnel of bamboo grove. Immediately after the forced landing into the bamboo grove, no lamps on the instrument panel were lit.

After some time had passed following her escape, the passenger entered into the overturned Aircraft to retrieve a tote bag she had left behind inside. When doing so, her right elbow touched a switch on the switchboard and she heard a click sound, although she was not sure what switch it was.

(3) Witness

The witness was working in a field approximately 50_m from the forced landing site. Although the Aircraft had made a loud sound while flying, when it was turned toward the bamboo grove, it flew straight like a paper airplane. There was no smoke coming from the Aircraft.

This accident occurred near Asanamihara, Matsuyama City, Ehime Prefecture. (34°00’17”N, 132°47’36”E) at about 10:04.

(See Figure 1: Estimated Flight Route and Photo 1: Accident Site)

2.2 Injuries to Persons

The captain suffered a minor injury.

2.3 Information of Damage to the Aircraft

2.3.1 Extent of Damage

The Aircraft was destroyed.

2.3.2 Damage to the Aircraft Components

Landing gear and fuselage:	Damaged
Windshield and door:	Damaged
Tail gear box:	Broken
Tail cone:	Bended
Drive system:	Partially broken
Main rotor and tail rotor:	Damaged

(See Photo 2: Accident Aircraft)

2.4 Personnel Information

Captain: Male, Age 50

Private pilot certificate (Rotorcraft) November 27, 2001

Type rating for single-piston (land) November 27, 2001

Class 2 aviation medical certificate

Validity April 12, 2013

Total flight time Approximately 980 hours

(According to the statement of the captain)

Flight time in the last 30 days Approximately 1 hour 30 minutes

(According to the statement of the captain)

Total flight time on the type of aircraft Approximately 80 hours

(According to the statement of the captain)

Flight time in the last 30 days Approximately 1 hour 30 minutes

(According to the statement of the captain)

2.5 Aircraft Information

2.5.1 Aircraft

Type Robinson R22 Beta

Serial number 3423

Date of manufacture March 11, 2003

Certificate of airworthiness DAI-2012-069

Validity May 30, 2013

Category of airworthiness Rotorcraft, Normal N

Total flight time 335.2 hours

Flight time since last periodical check (100 hours check on April 24, 2012) 20.2 hours

(See Figure 2: Three Angle View of Robinson R22 Beta)

2.5.2 Weight and Balance

When the accident occurred, the weight of the Aircraft is estimated to have been 1,232 lb

and the center of gravity (CG) is estimated to have been 97.6 inches aft of the reference point and 0.07 inches left of the centerline, all of which are estimated to have been within the allowable ranges (the maximum gross weight: 1,370 lb; the minimum gross weight: 920 lb; the CG range for the weight at the time of the accident: longitudinally 95.7 to 101.4 inches and laterally within 2.2 inches to the left and 2.4 inches to the right of the airframe symmetry plane.).

2.5.3 Fuel

- (1) Approximately 50 ℓ of fuel was refueled from Fuel Supplier A at Kumamoto Airport on March 12, 2013, and approximately 50ℓ of fuel was subsequently refueled from Fuel Supplier B at Matsuyama Airport.

No abnormalities were found in the quality test records for the fuel supplied from Fuel Suppliers A and B.

- (2) A fuel sample was taken from the fuel tank of the Aircraft, and a quality test in accordance with fuel standards (JIS K 2206) was conducted concerning density, distillation characteristics, existent gum, sulfur content, vapor pressure, the freezing point, copper corrosion, aqueous solubility, net heating value (calculated value), aniline/API, aviation octane rating, and tetraethyl lead. The results indicated that the liquid was aviation fuel and that the standards were satisfied, excluding the quality related to existent gum and aqueous solubility as follows.

<Examination results (excerpt)>

Oil properties	Test method	Measurement value	Standard value (JIS3)
Existent gum (unwashed)*2 [mg/100 ml]	JIS K2261	6	≤3
Aqueous solubility*3 Capacitance change	JIS K2276	17.5	≤2

2.5.4 Remarks on the Aircraft Flight Manual

- (1) As the procedure for starting the engine and run-up, the Aircraft Flight Manual of the Aircraft stipulates that the engine RPM should be set from 50% to 60% after starting the engine and that the alternator switch should be turned on after engaging the clutch.
- (2) The Aircraft Flight Manual of the Aircraft contains a description of the system of the Aircraft. The caution concerning the tachometers in the version at the time of the accident stated: “The installation of electrical device can affect the accuracy and reliability of the electronic tachometers, low RPM warning system, and governor. Therefore, no electrical equipment may be installed in the R22 helicopter unless that particular installation is specifically approved by the factory.”

*2 Existent gum is the residue left when the fuel sample is evaporated at the stipulated temperature and injection conditions. The JIS Handbook (issued by the Japanese Standards Association) states that "when there are large quantities of existent gum, it is highly likely that gum components could occur in the tank, which could cause deposits to accumulate in the inlet system adhere to the inlet valve, and impede with the fuel induction system; however, it is said that there is no correlation between gum quantity and the quantity of deposits in the inlet system."

*3 Aqueous solubility is the measure of mutual solubility between the fuel sample and water. Concerning water within petroleum products, the JIS Handbook states that "water is one factor that causes filters to become clogged at low temperatures, promotes the oxidation of oil, and causes the corrosion of metal."

2.6 Meteorological Information

According to the statement of the captain, the skies were clear, visibility was good, and there was no wind near the accident site.

The weather conditions measured at Matsuyama Airport, located approximately 22 km south-southwest of the accident site, around the time of the accident were as follows.

10:00 Wind direction: 220°; Wind velocity: 5 kt; Visibility: 15 km or more

Clouds: Amount: 1/8; Type: Cumulus; Cloud base: 3,000 ft

Temperature: 12°C; Dew point: 6°C

Altimeter setting (QNH): 30.22 inHg

2.7 Accident Site and Damage to Aircraft

The accident site is a hilly area near the sea located approximately 22 km north-northeast from Matsuyama Airport, and while there is a flat area with rice fields in front of the site, there are mountains with an altitude between 200 to 300 meters above sea level south-southwest from the site in the direction of Matsuyama Airport.

The Aircraft came into contact with bamboo trees with a height of approximately 25 meters and the upper portions of several bamboo trees were cut at an angle. The Aircraft fell to the ground on the tail cone, and the nose fell over to the right facing the northwest with the tail rotor falling off and the tail cone bent significantly.

(See Photo 1: Accident Site and Photo 2: Accident Aircraft)

2.8 Detailed Examination of Aircraft Components

The results of the detailed examination conducted on the Aircraft components after the accident are described below.

2.8.1 Aircraft Control System

The function of the control system of the Aircraft in relation to the operations of the cyclic stick and corrective pitch lever was examined, but no abnormalities were found.

As for the rudder pedal, the control rod was bent along with the tail cone and stuck.

2.8.2 Engine System

(1) Although the status of the components including the inlet system, exhaust system, and carburetor was examined, no traces of fuel or lubricating oil leaking were found, nor were there any traces of burns on the engine system parts or other abnormalities. Fallen leaves (bamboo leaves) had been sucked in the inlet and engine room.

No mechanical interference, constraints, or damage that could have an effect on the operations of the collective pitch lever or throttle, or the opening and closing of the carburetor valve was found.

(2) A visual inspection was conducted on the spark plugs and the wiring, but no abnormalities were found.

(3) In terms of remaining fuel, there were 19.2 US Gal in the main tank and 10.5 US Gal in the auxiliary tank. No abnormalities were found in the piping from each tank to the carburetor.

(4) The mechanical interlocking between the operations of the throttle/corrective pitch lever and the opening/closing of the carburetor valve was examined, but no abnormalities were found.

2.8.3 Electrical System

- (1) The operations of the warning and caution lights were examined with an external power source connected, but no abnormalities were found.
- (2) The switches for the navigation lights, strobe lights, and master battery were in the on position, and the switch for the alternator was in the off position.

The switches for the alternator and master battery are of the same construction and arranged right next to each other on the instrument panel.



Portion of the switch panel of the Aircraft (the yellow lines indicate the position of the switches at the time of on-sight investigation)

- (3) The operations and conditions of the switching structure for the alternator and master battery switches were examined, but no abnormalities were found.
- (4) The master battery that the Aircraft was equipped with was not the model specified by the manufacturer, but was rather one commercially available for small agricultural machinery and motorcycles, and had not been undergone inspections of repair or alteration as prescribed in Article 16 of the Civil Aeronautics Act. In terms of the history behind the installation of this battery, a replacement record was not included in the flight logbook and its installation was also unclear from the interviews conducted with the person that were involved.

The master battery had been completely discharged.

- (5) According to the information gained from the manufacturer of the Aircraft, the Aircraft requires the following electric current for starting up the engine and continuing to fly.

Engine start-up (30 seconds)	217.5 A
Flying after engine start-up	19.7 A

- (6) According to the information from the manufacturer of the Aircraft, the required voltage for operating the governor of the Aircraft is 10.0 to 16.8 V.
- (7) According to the information from the manufacturer of the Aircraft, the required voltage for operating the engine/rotor tachometer of the Aircraft is 10.0 to 16.8 V; however, past tests conducted by the manufacturer demonstrated that the engine/rotor tachometer operated at a supplied voltage of 7 to 8 V, which indicated that there would be a possibility that the instruments could indicate a reasonable RPM for a period of time even if the supplied voltage fell below 10.0 V.
- (8) An analysis was requested to the master battery manufacturer via the Aviation and Accident Investigation Board of South Korea, the state of design and manufacture of the master battery of the Aircraft. According to the analysis conducted by the manufacturer, when the electric current stated in 2.8.3 (5) is used while the alternator switch is off, the operating voltage stated in 2.8.3 (6) and (7) can be maintained for approximately 50

minutes from the engine start-up if the master battery charging rate is 100 %, for approximately 40 minutes if it is 90 %, and for approximately 30 minutes if it is 80 %.

2.8.4 Governor

A continuity test was conducted for the governor that controls the engine RPM, and the operations of the governor switch and caution light were examined, but no abnormalities were found.

The override mechanism and the mechanical interlocking between the operations of the throttle, and the opening/closing of the carburetor valve were examined, but no abnormalities were found.

A functional test of the governor was conducted by the manufacturer of the Aircraft, accompanied by a representative of the U.S.A, the state of design and manufacture of the Aircraft, but no abnormalities were found.

2.8.5 Clutch

The structure of the clutch was damaged along the tail cone curve.

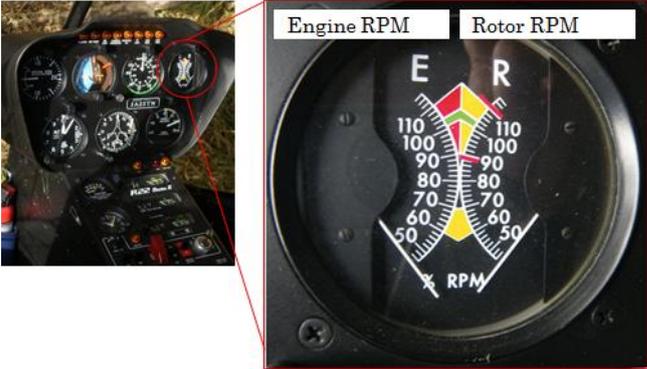
A portion of the clutch belt was torn.

2.8.6 Engine/Rotor Tachometer

The central instrument panel of the Aircraft is equipped with an instrument that displays the engine/rotor RPM.

The engine RPM that is displayed on the engine/rotor tachometer is detected based on the ignition signals from a magneto attached to the engine, and these signals are also sent to the governor. The rotor RPM is detected based on the pulse from two magnets attached to the rotation axis of the main gearbox.

-Pilot's Operating Handbook at the time of the accident (Excerpt)-

Engine RPM	Rotor RPM	Maximum engine speed	Rotor RPM limit	
		Maximum 104%	Power on	
			Maximum 104%	Maximum 104%
			Minimum 101%	Minimum 101%
			Power off	Maximum 110%
			Maximum 110%	Minimum 90%
			Minimum 90%	

Red: Operating limit. Pointer should not enter red during normal operation.

Yellow: Precautionary or special operating procedure range.

Green: Normal operation range.

Engine / Rotor tachometer of the Aircraft

A functional test of the magneto and tachometer was conducted by the manufacturer of the Aircraft, accompanied by a representative of the U.S.A, the state of design and manufacture of the Aircraft, but no abnormalities were found.

2.9. Search and Rescue Information

An accident report form the witness was received by the fire department at 10:04. The

captain and passenger escaped from the Aircraft on their own and both were taken to the hospital by an ambulance that arrived at the site.

3. ANALYSIS

3.1 Qualification of Personnel

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

3.2 Airworthiness of the Aircraft

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

However, as described in 2.8.3 (4), the master battery the Aircraft was equipped with was not the model specified by the manufacturer, but was rather one commercially available for small agricultural machinery and motorcycles, and had not been undergone inspections of repair or alteration as prescribed in Article 16 of the Civil Aeronautics Act.

3.3 Effects of Meteorological Conditions

It is highly probable that the meteorological conditions at the time of the accident had no bearing on the occurrence of the accident.

3.4 Conditions of the Aircraft

3.4.1 Aircraft Control System

As described in 2.1 (1), although the captain felt the response was oversensitive to rudder operations, he was able to control the Aircraft; he was able to turn it to the right, avoiding a mountain in the direction he was traveling in and aiming for a bamboo grove in his field of view, and reduce the speed with a flare. Moreover, as described in 2.8.1, the function of the control system of the Aircraft in relation to the operations of the cyclic stick and corrective pitch lever were examined, but no abnormalities were found.

Therefore, it is probable that there were no problems in the control system of the Aircraft.

3.4.2 Engine and Throttle

As described in 2.8.2 (4), no abnormalities were found in the mechanical interlocking between the operations of the throttle/corrective pitch lever and the opening/closing of the carburetor valve. Moreover, as described in 2.8.4, no abnormalities were found in the override function of the governor.

It is highly probable that when the captain noticed an abnormality in the engine while cruising, he was able to control the engine RPM by operating the throttle.

3.4.3 Alternator

As described in 2.8.3 (2), the switch for the alternator was in the off position at the time of the on-sight investigation.

However, as described in 2.1 (1) and (2), both the captain and passenger stated that the caution light was not lit. In addition, the passenger stated that when she returned to get her belongings after once escaping from the Aircraft, her right elbow touched a switch on the switchboard and that she heard a click sound.

Although the situation at the time was analyzed according to this statement by the passenger, it could not be determined whether the alternator switch was moved into the off position as a result of the passenger touching it after the accident or it had been off during the

flight.

3.4.4 Governor

As described in 2.1 (1), the captain stated that he noticed an abnormality in the engine sound and that the indication of the manifold pressure indicator was abnormally high. However, as described in 3.4.2, no abnormalities were found in the engine control mechanism.

Therefore, as it is probable that the reasons the captain noticed an abnormality in the engine might have been the break-down of the governor, the suspension of the governor operation, an abnormality in the control mechanism for the engine RPM, or the override of the governor by the captain, the possibility of these factors was examined.

(1) Break-down of the governor

As described in 2.8.4, the governor was not broken.

(2) Suspension of the governor operation

As described in 2.8.3 (2), the switch for the alternator was in the off position at the time of the on-site investigation. If the alternator power switch was in the off position during the flight, it is somewhat likely that there was no power supply from the alternator, which caused the master battery power to be consumed leading to a lack of the power supply required to operate the governor, which in turn caused the operation of the governor to be suspended.

However, as described in 3.4.3, it could not be determined when the switch had become in the off position.

(3) Abnormality in the engine RPM control mechanism

As described in 2.8.2, there were no abnormalities in the engine of the Aircraft.

(4) Override of the governor by the captain

As described in 2.1 (1), the captain stated that he noticed an abnormality in the engine sound while flying at an altitude of approximately 1,000 ft and at a speed of approximately 80 kt and that he did not notice any particular abnormalities up until then; therefore, it is not very likely that the captain opened the throttle and overrode the governor.

In consideration of the above, it is somewhat likely that the reason the engine/rotor RPM increased involved the power switch of the alternator being in the off position during the flight and there being no power supply from the alternator, which caused the master battery power to be consumed leading to a lack of the power supply required to operate the governor, which in turn caused the operation of the governor to be suspended.

However, as described in 3.4.3, because it could not be determined when the switch had become in the off position, the reason the engine/rotor RPM had increased remained unknown.

3.4.5 Clutch

As described in 2.8.5, damage was found on a portion of the clutch belt.

Because no scratch marks, traces of abnormal friction, or deformation indicating the abnormal rotation of the clutch belt was found, it is probable that this was made upon impact during the forced landing.

3.5 Fuel analysis

As described in 2.5.3 (2), while the test conducted based on fuel standards indicated that the quality related to existent gum and aqueous solubility failed to satisfy the standards, the other items met the standards.

It is possible for deposits to accumulate in the inlet system and adhere to the inlet valve, causing an impediment with the fuel induction system if fuel not in conformance with existent gum standards is used continuously; however, as described in 2.8.2, no abnormalities were found in the piping from the tanks to the carburetor or in the carburetor.

Moreover, it is possible for water to congeal, blocking the fuel filter and piping, or causing fuel flow to become uneven, which promotes oxidation of fuel and leads to the corrosion of metal if fuel not in conformance with aqueous solubility standards is used continuously; however, this will not cause engine over-speeding as stated by the captain.

For this reason, it is highly probable that fuel quality was not involved with the engine abnormality described by the captain.

3.6 Captain's Operations and Judgment of Conditions

3.6.1 Captain's Judgment of Conditions

As described in 3.4.2, it is possible to control the engine RPM even if the governor is suspended; therefore, it is probable that when the captain noticed an abnormality in the engine while cruising, lowered the corrective pitch lever, and closed the throttle a bit, the engine RPM was decreased, leaving only the rotor in an over-speeding state.

However, it is probable that because the captain did not expect the engine/rotor RPM to increase during the time period between when the captain noticed an abnormality and when he decided to make a forced landing and because they were advancing into a mountain and needed to make a quick response, when the Aircraft sound and vibrations did not stop after lowering the corrective pitch lever and closing the throttle a bit, the captain judged without confirming the engine/rotor tachometer that the engine was over-speeding and out of control and thus decided to make a forced landing without an accurate understanding of the situation.

In order to properly deal with such a situation, a pilot needs to confirm the indications of the engine/rotor tachometer when he or she notices an abnormality in the engine and operates the throttle and control pitch lever while monitoring those indications to keep the RPM within the range of standard operations.

3.6.2 Forced Landing Location Judgment

Usually, when conducting a forced landing, a location that is flat with no obstructions in the vicinity is selected.

As indicated in the photo of Figure 1, it is highly probable that the captain would have been able to avoid the mountain in the direction he was traveling in and find a flat place for forced landing by turning the Aircraft to the left or the right, where there are rice fields.

As described in 2.1 (1), the captain believed that the engine was over-speeding and out of control and that the engine would soon break. He stated that because a bamboo grove happened to come into his field of view when he turned the Aircraft to the right to avoid the mountain in the direction he was traveling in, he decided to make a forced landing aiming for the grove.

Therefore, it is somewhat likely that the captain prioritized the reduction of the impact upon forced landing and selected the bamboo grove as the forced landing site without an accurate understanding of the status of the Aircraft.

4. CONCLUSIONS

4.1 Probable Causes

It is probable that when the engine/rotor RPM increased while cruising to the destination airport, the captain could not deal with the situation, which led him to aim for a bamboo grove to make a forced landing, and that the airframe was damaged at the time.

It is probable that the reason the captain could not deal with the situation is because he decided that the cause of the rotor over-speeding was that the engine was over-speeding and out of control, without confirming the engine/rotor RPM from the indication of the tachometer.

It is somewhat likely that the reason the engine/rotor RPM increased involved the power switch of the alternator being in the off position for some reason and there being no power supply from the alternator, which caused the master battery power to be consumed leading to a lack of the power supply required to operate the governor, which in turn caused the operation of the governor to be suspended. However, because it was not possible to identify when the alternator switch became in the off position, it could not be determined why the RPM increased.

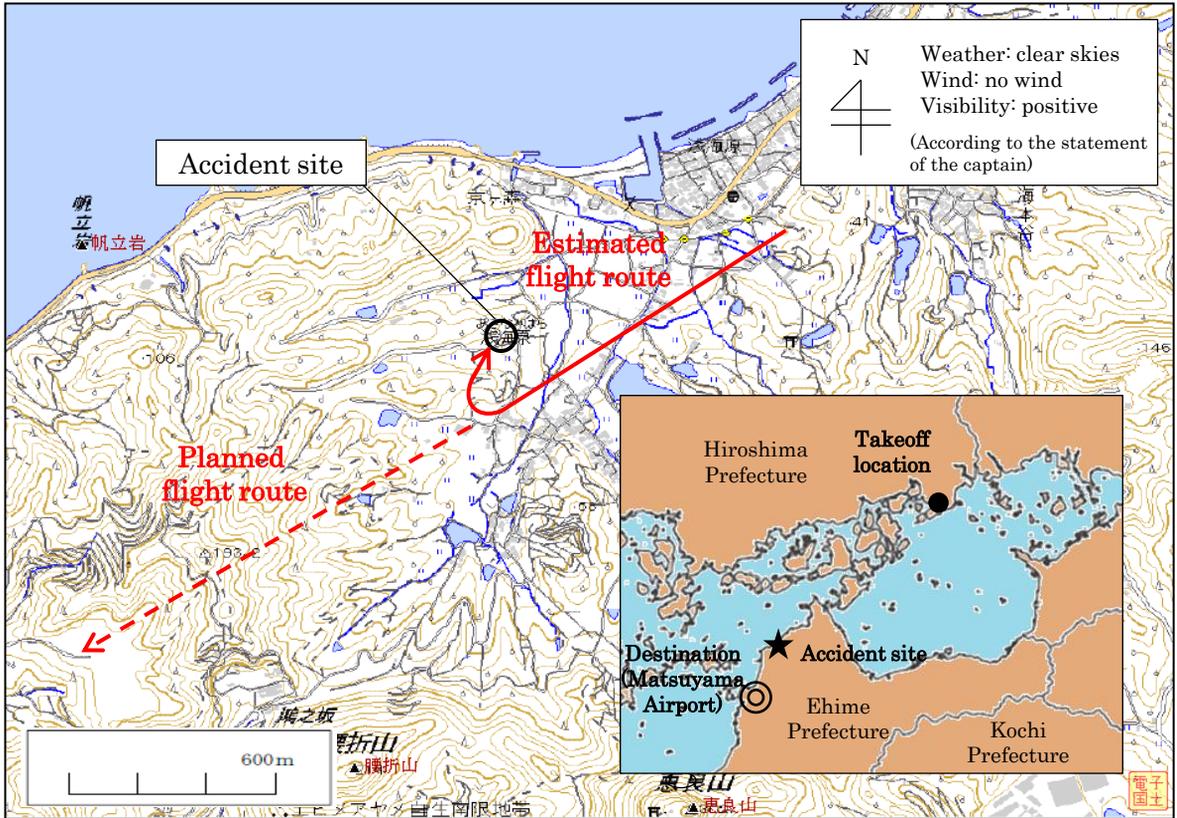
4.2 Other Safety Related Findings

The master battery the Aircraft was equipped with was not the model specified by the manufacturer, but was rather one commercially available for small agricultural machinery and motorcycles, and had not been undergone inspections of repair or alteration as prescribed in Article 16 of the Civil Aeronautics Act.

Because non-standard parts have not been certified through testing as to whether they are compatible with the aircraft design or manufacturing standards, it is not clear what impact they have on the airworthiness of aircraft.

Operators should use specified parts that are compatible with the aircraft design or manufacturing standards.

Figure 1 Estimated Flight Route
 (According to the statements of the captain and witnesses)



1 : 25,000 Scale Topographic Map by Geographical Survey Institute

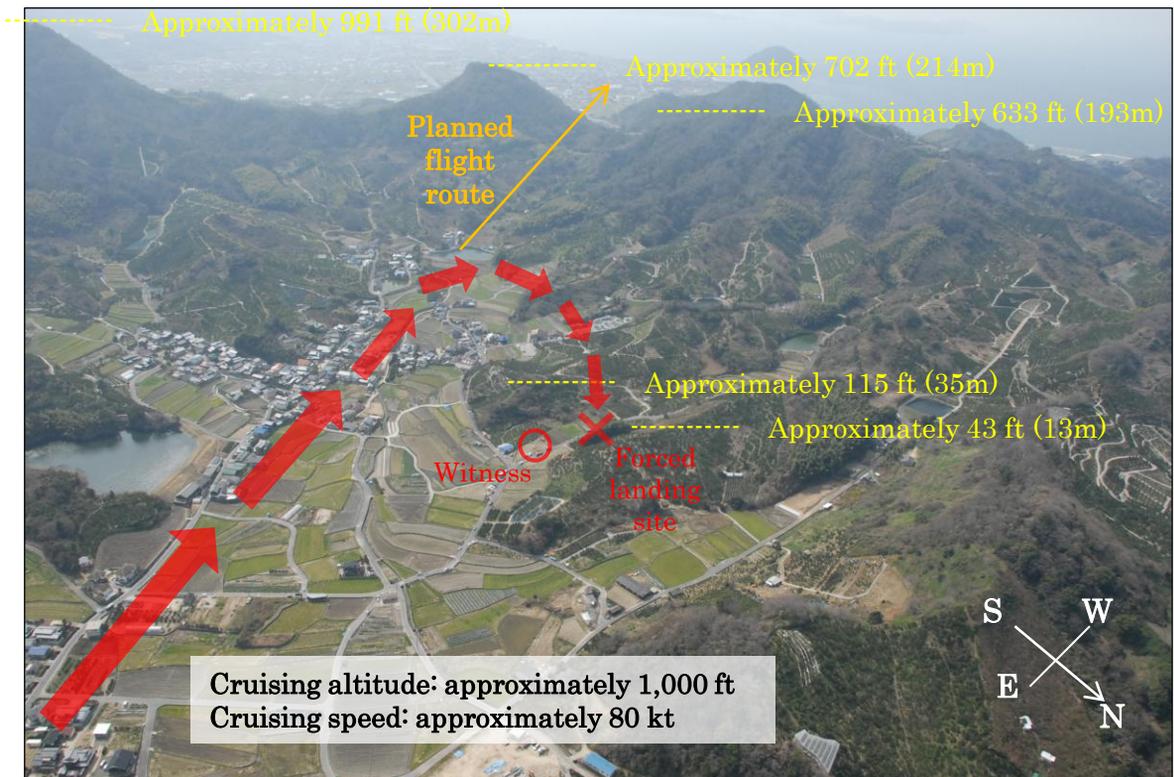


Figure 2 Three Angle View of Robinson R22 Beta

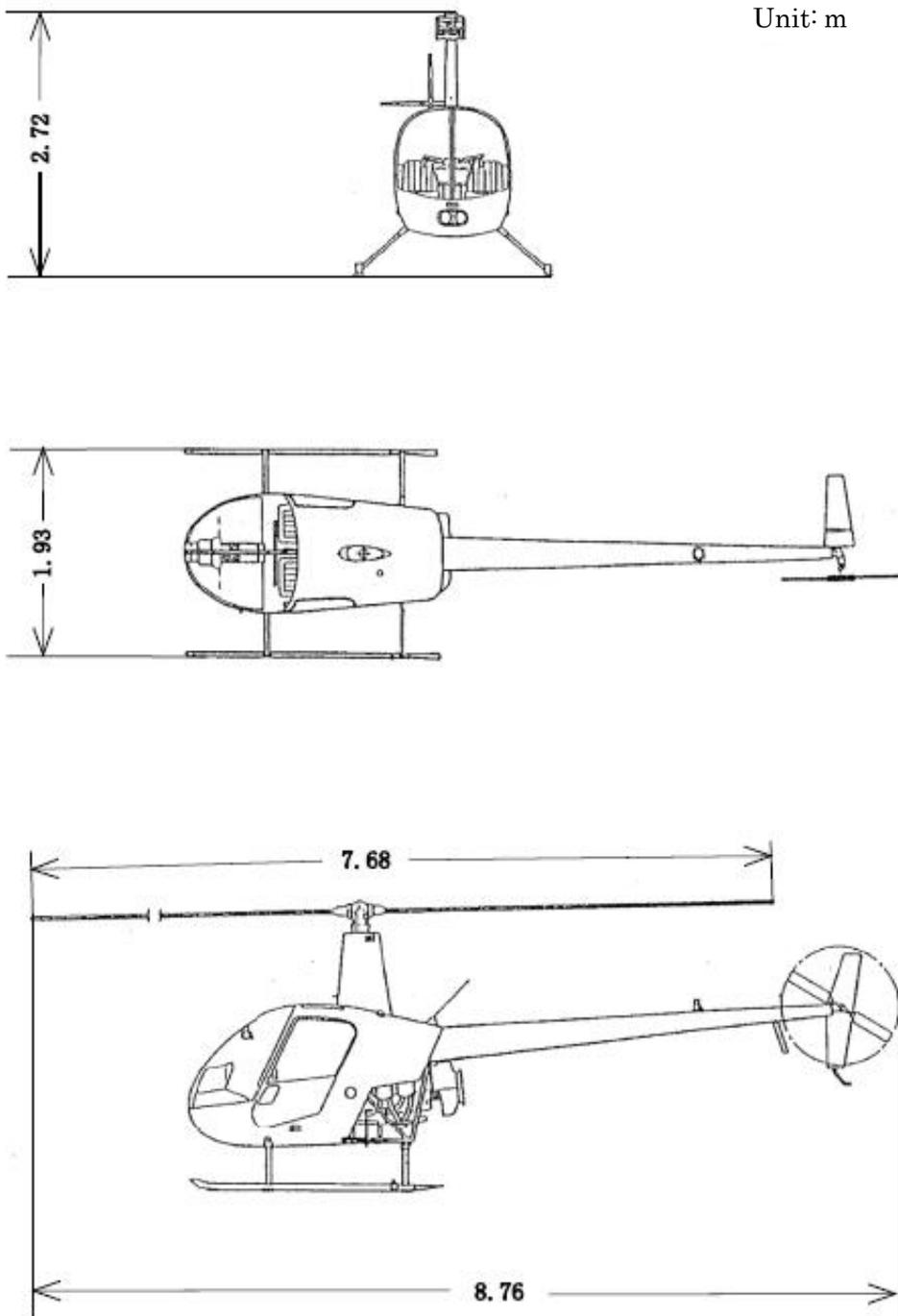


Photo 1 Accident Site

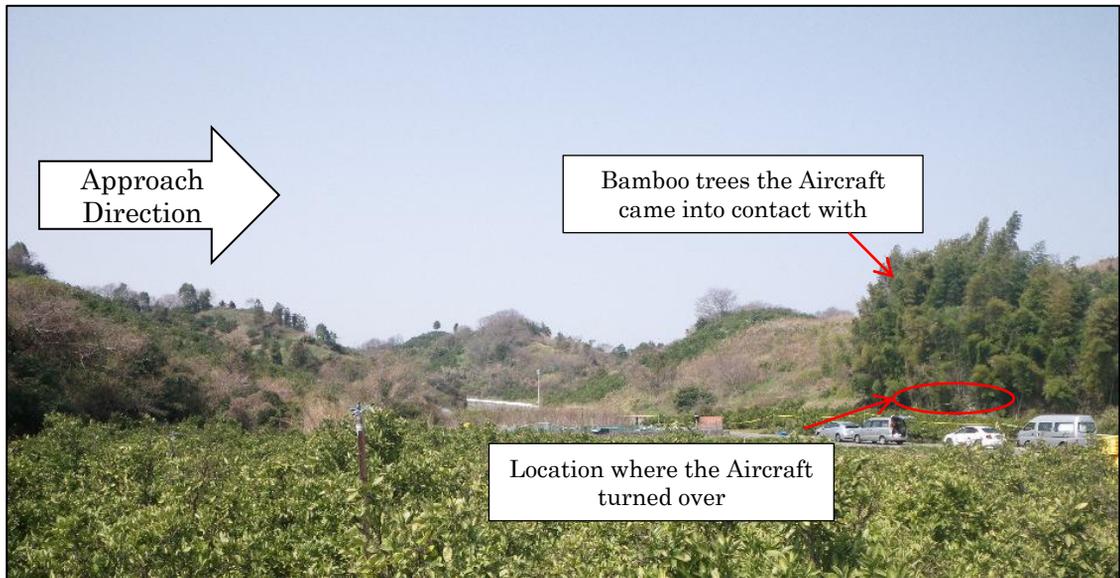


Photo 2 Accident Aircraft

