AA2011-6

AIRCRAFT ACCIDENT INVESTIGATION REPORT

PRIVATELY OWNED

J A 2 2 N E

September 30, 2011

Japan Transport Safety Board

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

PRIVATELY OWNED
ROBINSON R22 BETA (ROTORCRAFT), JA22NE
KAMOTO-MACHI, YAMAGA CITY, KUMAMOTO PREFECTURE, JAPAN
AROUND 14:01 JST, AUGUST 1, 2010

August 19, 2011
Adopted by the Japan Transport Safety Board
Chairman Norihiro Goto
Member Shinsuke Endoh
Member Toshiyuki Ishikawa
Member Sadao Tamura
Member Yuki Shuto
Member Toshiaki Shinagawa

1. PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Accident

On August 1 (Sunday), 2010, around 14:01 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 JA22NE, crashed in a paddy field about 160 m north of the Kamou Helipad in Miuta, Kamoto-Machi, Yamaga City, Kumamoto Prefecture during approach for landing after finishing a familiarization flight,

The captain and one passenger were on board the aircraft, and both of them were killed.

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

1.2 Outline of the Accident Investigation

1.2.1 Investigation Organization

On August 1, 2010, the Japan Transport Safety Board designated an investigator-in-charge and another investigator to investigate this accident. On August 10, 2010, JTSB designated another investigator for this accident.

1.2.2 Representative from Foreign Authorities

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

August 2 and 3, 2010	Interviews and on-site investigation
August 4 and 5, 2010	Aircraft examination
November 16, 2010	Examination of the same type of aircraft

1.2.4 Comments from Parties Relevant to the Cause of the Accident

Comments from the captain and the passenger aboard the aircraft as the parties relevant to the cause of the accident were not invited, because of their decease.

1.2.5 Comments from the Participating State

Comments were invited from the participating State.

2. FACTUAL INFORMATION

2.1 History of the Flight

On August 1, 2010, a privately owned Robinson R22 Beta, registered JA22NE (hereinafter referred to as “the Aircraft”), took off from Iki Airport at 13:07 for the purpose of familiarization flight with the captain seated on the right side and the passenger on the left side, and began to fly toward an officially registered helipad as Kamou Helipad.

The outline of the flight plan was as follows:

Flight rule:	Visual Flight Rule (VFR)
Departure aerodrome:	Iki Airport
Estimated off-block time:	13:10
Cruising speed:	80 kt
Cruising altitude:	VFR

Route:	Karatsu
Destination aerodrome:	Kamou Helipad
Total estimated elapsed time:	1 hour and 20 minutes
Purpose of flight:	Familiarization flight
Fuel load expressed in endurance:	3 hours and 30 minutes
Persons on board:	2

The history of the flight up to the accident is summarized as below, based on the records on a portable GPS on board the Aircraft and the statements by witnesses and others.

2.1.1 History of Flight According to Records on Portable GPS

13:07	The Aircraft took off from Iki Airport.
13:56	The Aircraft commenced a descent from an altitude of about 1,800 ft at a point about 9 km west of Kamou Helipad. The ground speed (GS: a calculated value based on the GPS data; the GS mentioned hereinafter are indicated in the same manner) was about 78 kt.
14:00:34	The Aircraft passed a point about 900 m west-northwest of Kamou Helipad at an altitude of about 300 ft above ground level of the helipad (AGLH). It was descending at a GS of about 65 kt.
14:00:51	The Aircraft reached a point above utility lines located along the northern side of City Road 121 running almost east and west about 170 m north of the Helipad, at an altitude of about 150 ft AGLH. The GS was about 63 kt. After that, the Aircraft drifted to the left and while flying almost above the utility lines, it descended from about 150 ft AGLH to about 110 ft AGLH.
14:01:00	The Aircraft crossed above the utility lines and the road diagonally to the right, descending at an altitude of about 60 ft AGLH.
14:01:02	The recording of the data on the GPS came to an end at the accident site.

2.1.2 History of Flight According to Statements by Witnesses and Others

(1) A pilot who was flying ahead of the Aircraft (Pilot A)

The Pilot A joins to the same organization as the captain of the Aircraft and the passenger. The Pilot A did a preflight preparations and checks beside the Aircraft before the takeoff, but he observed nothing unusual with the Aircraft.

The Pilot A took off from Iki Airport around 13:02 and came to know, by monitoring a radio transmission, that the Aircraft took off about five minutes later. Over Karatsu on the flight route, the Pilot A received a radio call from the captain of the Aircraft that he was following the Pilot A's aircraft maintaining a visual contact. At that time, the Pilot A was flying at an airspeed of about 80 kt at an altitude of about 1,500 ft. Later, it climbed to about 2,000 ft and flew over Saga Airport. After leaving the Saga Information Zone, which extends 5 nm radius of the airport, the Pilot A received a radio call from the Aircraft that it would fly toward Yamaga City, its destination. After leaving company the Pilot A flew toward Kumamoto Airport as its destination and he changed the frequency. Therefore, there was no communication with the Aircraft after that. Until then, the Pilot A had not received any message of anomaly on the Aircraft.

(2) Witness A

The weather was fine and visibility was good on the day of the accident. The witness A was in a front passenger seat of a car, which was traveling eastward on a road running east and west to the north of the accident site. The witness A spotted the Aircraft flying above on the left side at a place about 300 m away from the accident site. Just after that, the Aircraft passed diagonally over the utility lines on the left side of the road, and beyond the road it started falling in a steep angle with its speed almost unchanged. The witness A heard no sound because he was in the car. The Aircraft appeared to be falling while turning to the right with its head slightly lowered. The main rotor (hereinafter referred to as the "MR") turning speed before the crash appeared to be conspicuously slower than before.

After the car stopped near the accident site, the witness A rushed to the Aircraft and sensed a strong smell like burning rubber. The Aircraft was lying on its right. No sound was heard from it. When the witness A uttered "Are you all right?" in a loud voice to the person who was sitting in the left seat in the cabin, the person showed some reaction. When the witness A had a closer look at the cabin, there was also a person in the right seat. The person looked soaked in the muddy water. The witness A, together with several other people who came to the crash site, raised the right side of the Aircraft and pulled the man in the right seat out of water. They rescued the man in the right seat first of all because his seat belt was unbuckled first. After that, they rescued the man in the left seat and transferred the two to an ambulance which came to the place.

(3) Witness B

The witness B saw the Aircraft flying at a place about 200 m northwest of the accident site. The Aircraft came from the west (the right side) and flew eastward (to the left side) over the roof of a workshop which was located to the south. It was seen only briefly because the field of view was limited by trees and other objects, but it was seen flying on the north side of the road which runs north side of the accident site. The Aircraft went out of his sight when it appeared to start turning by banking to the right without reducing its fast speed. After a little while, the witness B heard a surprisingly big bang.

This accident occurred at a paddy field about 160 m north of Kamou Helipad (Latitude 33°00'54" N and Longitude 130°44'03" E) at about 14:01.

(See Figure 1 Estimated Flight Route, Figure 2 Accident Site Layout, Photo 1 Accident Site)

2.2 Injuries to Persons

Both the captain and the passenger were killed.

2.3 Damage to the Aircraft

2.3.1 Extent of Damage

Destroyed

2.3.2 Damage to the Aircraft Components

(1) Fuselage	Damaged
(2) Tail cone	Fractured, detached
(3) Landing gear	Deformed, damaged
(4) MR blades	Deformed

(5) Tail rotor (hereinafter referred to as the “TR”) and tail wing
Detached

(6) Aircraft control system — Partially fractured

(7) Engine — Damaged

(See Photo 2 The Accident Aircraft (Overview))

2.4 Personnel Information

(1) Captain — Male, Age 62

Private pilot certificate (Rotorcraft)	November 12, 1997
Type rating for single-piston (land)	November 12, 1997
Class 2 aviation medical certificate	
Validity	August 1, 2011
Total flight time	866 h 28 min
(292 h 03 min of which were in fixed wing aircraft)	
Flight time in the last 30 days	5 h 40 min
Total flight time on the type of aircraft	574 h 25 min
Flight time in the last 30 days	5 h 40 min

(The times mentioned above were calculated from the flight log book data until July 27, 2010)

(2) Passenger — Male, Age 61

Private pilot certificate (Rotorcraft)	August 26, 1999
Type rating for single-piston (land)	August 26, 1999
Class 2 aviation medical certificate	
Validity	October 5, 2010
Total flight time	Unknown
Flight time in the last 30 days	Unknown
Total flight time on the type of aircraft	Unknown
Flight time in the last 30 days	Unknown

(Unknown because flight records and other materials were unavailable)

2.5 Aircraft Information

2.5.1 Aircraft

Type	Robinson R22 Beta
Serial number	2861
Date of manufacture	September 1, 1998
Certificate of airworthiness	DAI-21-469
Validity	November 24, 2010
Category of airworthiness	Rotorcraft, Normal N
Total flight time	663 h 54 min
Flight time since last periodical check (100h check on November 15, 2009)	51 h 06 min

(The time mentioned above was calculated from the flight logbook data until July 27,2010)

(See Figure 3 Three Angle View of Robinson R22 Beta)

2.5.2 Engine

Type	Lycoming O-360-J2A

Serial number	L-36015-3
Date of manufacture	March 2, 1998
Total time of use	663 h 54 min
Flight time since last periodical check (100h check on November 15, 2009)	51 h 06 min

(The time of use mentioned above was calculated from the flight logbook data until July 27, 2010)

2.5.3 Weight and Balance

When the accident occurred, the Aircraft's weight is estimated to have been 1,280.3 lb and the center of gravity (CG) is estimated to have been 248.5 cm aft of the reference point and 0.5 cm right of the centerline, all of which are estimated to have been within the allowable ranges (the maximum gross weight of 1,370 lb, the minimum gross weight of 910 lb, the CG range for the weight at the time of the accident: longitudinally 243 to 259 cm and laterally within 5.5 cm to the left and 5.5 cm to the right of the airframe symmetry plane.).

2.5.4 Fuel and Lubricating Oil

Fuel was Aviation Gasoline 100 (AVGAS100), and lubricating oil was MIL-L-22851(Phillips20W-50).

2.6 Meteorological Information

(1) Wind direction, wind velocity and outside air temperature

Following are the readings of the wind direction, wind velocity and outside air temperature (OAT) recorded between 13:50 and 14:10 on the day of the accident in Kikuchi, Mashiki and Kumamoto by Automated Meteorological Data Acquisition System of the Japan Meteorological Agency (AMeDAS).The latter places are located in a flat area which extends to the south of the accident site (The average wind velocity is the average of the last 10 minute data, and the wind velocity is converted from m/s to kt.):

(a) Kikuchi (about 8.7 km southeast of accident site, an elevation of 83 m)

Time	13:50	14:00	14:10
Average wind direction	Southwest	Southwest	Southwest
Average wind velocity	5.4 kt	5.3 kt	5.6 kt
Wind direction when maximum instantaneous wind velocity was recorded	West-southwest	Southwest	Southwest
Maximum instantaneous wind velocity	11.3 kt	12.3 kt	9.9 kt
OAT	31.0 °C	31.5 °C	32.5 °C

(b) Mashiki (about 22.5 km southeast of accident site, an elevation of 193 m)

Time	13:50	14:00	14:10
Average wind direction	Southwest	West-Southwest	West-Southwest
Average wind velocity	9.9 kt	10.3 kt	8.7 kt
Wind direction when maximum instantaneous wind velocity was recorded	Southwest	West-southwest	West
Maximum instantaneous wind velocity	15.9 kt	15.0 kt	15.0 kt
OAT	31.7 °C	31.6 °C	30.8 °C

(c) Kumamoto (about 22.5 km south of accident site, an elevation of 38 m)

Time	13:50	14:00	14:10
Average wind direction	West-southwest	West-southwest	West-southwest
Average wind velocity	10.8 kt	11.3 kt	11.5 kt
Wind direction when maximum instantaneous wind velocity was recorded	Southwest	West-southwest	Southwest
Maximum instantaneous wind velocity	16.9 kt	17.5 kt	18.3 kt
OAT	32.4 °C	32.3 °C	32.4 °C

(2) Density altitude

The density altitude*1 at the accident site (an elevation of 69 m (226 ft)) was about 2,200 ft, when calculated from the OAT of about 32 °C at that time at Kikuchi, which is the closest to the accident site and has almost the same elevation as that of the site.

2.7 Accident Site and Wreckage Information

2.7.1 Accident Site

(1) General layout of Kamou Helipad

Kamou Helipad is located in a paddy field at the northern end of flat land extending to the north of the Kumamoto Plain and it has an elevation of 69 m. The helipad is an almost square grassy lot with each side length of about 10 m. The directions of approved approach paths were 020° and 200° in the magnetic reading.

City Road 121 extends east to west about 170 m north of the helipad, while Prefecture Road 197 runs north to south about 120 m east of the area. Utility lines with a height of about 12 m (40 ft) AGL run along the two roads.

For an approved 200° landing, the Aircraft has to fly over a housing area north of City Road 121, followed by a flight over a paddy field between two greenhouses located about 50 m apart.

A windsock had been set up at the helipad.

(See Figure 1 Estimated Flight Route, Figure 2 Accident Site Layout, Photo 1

*1 The density altitude denotes an altitude which is indicated with the standard atmosphere which can produce the same figure when compared with the air density of the standard atmosphere. This altitude affects the engine, flight and other performances of helicopters.

Accident Site)

(2) The accident site

The accident site was in a paddy field about 160 m north of Kamou Helipad. The paddy was muddy due to the irrigation.

There was a depression about 5 m in diameter and about 30 cm in depth at a place about 12 m south of City Road 121. The Aircraft came to rest on its right side about 7 m east from the depression orienting to the west. But it was raised upright when the occupants were rescued.

The tail cone and the TR, which had been fractured, were found at a place about 6 m from the aircraft on an extended line drawn from the depression, while small pieces of broken components were found around the aircraft. .

(See Figure 2 Accident Site Layout, Photo 1 Accident Site)

2.7.2 Details of Damage

(1) Landing gear, fuselage and tail cone

The forward cross tube*2 was stuck in the bottom of the fuselage and deformed, while the aft cross tube was found fractured in its middle area. The two skids were widened apart.

The right skid was fractured at the joint with the forward strut and was uprighted pivoting around the joint with the aft strut.

As for the cockpit components, the forward canopy had been detached, while the lower instrument panel and the console had been deformed to the left.

The tail cone was bent downward slightly to the right at a point about one third of its total length from the fuselage and detached there. The deformation at the detached section appeared as if rest of the cone were torn forward in the direction to the fuselage.

(See Photo 1 Accident Site, Photo 2 The Accident Aircraft (Overview))

(2) Engine and driving system

a. There was no major damage in the appearance, but the throttle valve control was stuck at the lower part of the left seat and the throttle arm was jammed.

b. When the engine was manually rotated with no binding.

c. The slip mark*3 in the fan wheel assy as part of the cooling system was displaced to a position of engine over speed.

d. The lower ignition plugs of four cylinders exhibited healthy electrode condition and they were in dry condition, however, grains of muddy powder were in the plugs.

e. On the walls of air intake ports of the No. 1 and No. 3 cylinders, there were chunks of wet mud, while the inside of exhaust pipe were free of mud and dry.

f. A defined amount of engine lubricating oil was in the tank, and an analysis showed no anomaly in its quality.

g. The two driving belts had been removed from the upper sheave*4 in the clutch assembly.

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*2 The "cross tubes" are installed over the skids as part of landing gear for skid-type models. They form a base-like part of the fuselage to absorb the shock of landing by a deflection.

*3 The "slip mark on the fan wheel assy" shows a position where the fan wheel assy for air cooling is fixed with a nut to the engine driven shaft. It is designed to indicate the engine over speed by its displacement from the designated place.

*4 The "upper sheave" is installed in the upper part of the clutch assembly linked with a V belt to the engine driven lower sheave. It drives the shaft which rotates the MR and the TR.

One of them was found split longitudinally in the valley-like area of the belt.

h. Continuity between the upper sheave and MR shaft was established by manually rotating the former.

i. A defined amount of lubricating oil was in the MR gear box, and an analysis revealed no anomaly in its quality.

j. A power line connector for sending engine RPM signal to the engine tachometer and the RPM governor system*5 was disconnected at its joint.

(See Photo 3 The Accident Aircraft (Engine))

(3) MR and TR

a. Both of the two MR blades was bent slightly backward to the rotational direction. Wrinkles were found on the blade surfaces, but there were no cracks or abrasion. Mud and others objects were little seen on the blades.

b. T-shaped cyclic control is installed. Continuity between the cyclic and the swash plate was established without binding.

c. The collective pitch lever (hereinafter referred to as the "C/P") was in the full down position.

Continuity between the C/P and the MR was established without binding.

d. One of the two MR pitch links as part of the blade control system was fractured. The damaged section was examined with the cooperation of the Japan Aerospace Exploration Agency, an independent administrative entity, but no sign of fatigue damage was found.

e. The rudder pedal that controls the TR was in the full left input position. Because the pedal was found touching the deformed console, it was almost unmovable from the position.

(See Photo 2 Accident Aircraft (Overview))

(4) Fuel system

About 58 l of fuel had been left in the fuel tank.

A small amount of grain-like material was found in the fuel filter, but the filter was not clogged up.

An analysis of the fuel showed no anomaly in its quality.

(5) Flight instruments

No instruments in the cockpit appeared damaged. The clock was stopped showing 14:01.

The altimeter setting was 29.82 inHg. (Pressure reading at Iki Airport as of takeoff and Saga Airport as of overpass was 29.81 inHg.)

2.8 Medical Information

According to an autopsy performed by the Kumamoto Prefectural Police Headquarters, it is considered highly probable that the cause of death for the captain and the passenger was traumatic shock due to multiple trauma injuries.

Neither alcohol nor drug substance were found in either of their blood. There were no bone fractures in their wrists or ankles.

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*5 The "RPM governor system" is an electronic 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.

2.9 Search and Rescue

The accident was reported to a fire station at 14:01 by a witness who happened to be passing by the accident site. The captain was rescued from the right seat in the cockpit and then, the passenger from the left seat by the witness and several other people who later passed by the area. The two persons were transferred to two ambulances which arrived there at 14:09 and 14:19. Both of them were later confirmed dead at the hospitals which they were sent to.

2.10 Tests and Researches for Fact-Finding

2.10.1 Examination of Portable GPS Receiver

An analytical examination was performed on the portable GPS receiver which is believed to have been brought into the cockpit by the captain.

(1) Flight data from the time of the Aircraft's takeoff to the time of the accident was retained.

(2) The data covering 12 flights prior to the accident was retrieved and analyzede. Of these, nine landings, twice to airport runways and seven times to the Helipad, were compiled in a table with the data for the latest accident attached for comparison.

(See Figure 4 Comparative Table with the Past Flight Data of the Aircraft)

2.10.2 Examination of the Same Type of Aircraft

(1) Interview about flight operations

An interview was made to a flight instructor of the Aircraft and same type of the aircraft on the flight operations and other related matters. Comments obtained in the interview are summarized as below.

a. A final approach usually begins in headwind as indicated in the flight manual at an altitude of 300 ft AGL and with an airspeed of 60 kt. With a usual descent angle of 8º, the speed and the altitude must be reduced smoothly on a straight course traveling about 600 m before terminating in a hovering.

In a usual approach, the airspeed is approximately 30 kt at the middle point on the final course at 150 ft AGL.

b. In case where the speed was not reduced by the middle point and maintained at 60 kt, a quick deceleration within 300 m is necessary, in which the C/P must be lowered further than a normal descent (The throttle position should be around the idle position with a manifold pressure of about 12 inHg exceeding the normal descent manifold pressure of about 15 inHg) for increased rate of descent, followed by a nose-up attitude for a quick reduction airspeed. Because this is quite different from the normal control procedure and difficult to perform, a go-around should be chosen, rather than continuing landing.

c. Under the condition of cross wind approach with fitful gusts, yawing occurs following changes in the wind velocity. With an attempt to stop this by adding a left rudder input hard, the MR RPM may be decayed temporary. Therefore, caution must be paid for the control.

d. When the MR RPM decays, the RPM must be restored by immediate throttle opening and concurrent lowering of the C/P. When it has a forward speed, the cyclic stick must be applied aft to restore the RPM (by making use of the speed).

If the C/P is raised under the low RPM condition, quick over-pitching (the condition where available power is exceeded) occurs. The RPM may rapidly decay before the RPM governor starts to operate, causing a catastrophic stall of the MR leading to the loss of entire lift. Therefore, caution must be paid.

(2) Examination of engine power

The Aircraft has two ways for the throttle valve control: rotation of the throttle grip: a correlation mechanism which is linked by up-down movement of the C/P. The power setting of the Aircraft at the time of the accident was confirmed by setting the cross examined aircraft's throttle position to that of the Aircraft.

a. Under a condition of the engine not running and the C/P set almost in the full down position, cross examined helicopter's throttle grip was opened to a confirmed throttle arm position of the Aircraft. The position proved to be about 50% full open position

b. Under a condition of engine running and the C/P set almost in the full down position, above mentioned condition was recreated with the throttle grip turning. The engine RPM was about to exceed the limit of 104 %, indicating that the throttle position is beyond the operational range.

c. Under a condition of engine running and the C/P set almost in the full down position, the C/P was gradually pulled up from the full down position letting the linkage mechanism to open the throttle until the throttle arm position corresponds to that of the Aircraft.

As a result, cross examined helicopter's C/P position was at half point of its full travel. Corresponding manifold pressure was about 21 inHg (a maximum continuous power is about 22.5 inHg), equivalent power which can maintain a hovering at an altitude of about one meter AGL.

(See　Figure 5　The Throttle Valve Control)

2.11 Additional Information

2.11.1 Records of Landing at Kamou Helipad

According to the aircraft logbook for the Aircraft and flight logbook of the captain, he had accumulated 22 landings at Kamou Helipad between November 3, 2002 and the day before the accident (an average of about twice a year in the past five years). No information was available for the passenger because his flight records were not found.

2.11.2 Captain's way of Landing at Kamou Helipad mentioned by witnesses

Two witnesses mentioned how the captain landed at Kamou Helipad in the past. Each of them saw the Aircraft landed in the southward direction five times in the past. When it lands on the heliport southwardly, the Aircraft always came from the west through an area south side of the utility lines, reduced the altitude and the speed over the paddy fields, slowly turned to the right and made an approach. It appeared that it reduced its speed and altitude at a place slightly far-side of the accident site.

The Aircraft landed on the heliport after slowly passing between the two greenhouses in order to avoid damage to them.

When the Aircraft landed southwardly, they have not seen it approach straight toward the heliport after flying over the housing area north side of the city road.

2.11.3 Descriptions on Flight Manual

The flight manual for the Aircraft includes the following descriptions, in Chapter 3 Emergency Procedures, Chapter 4 Normal Procedures, and Chapter 10 Advice for Safety Operations: (Excerpt)

(1) Emergency procedures

3-19 LOW RPM HORN & CAUTION LIGHT

A horn and an illuminated caution light indicate that rotor RPM may be below safe limits. To restore RPM, immediately roll throttle on, lower collective and, in forward flight, apply aft cyclic. Horn and caution light are disabled when collective is full down.

(2) Normal procedures (Final approach)

4-13 APPROACH AND LANDING

(1) Make final approach into wind at lowest practical rate of descent with initial airspeed of 60 kt.

(2) Reduce airspeed and altitude smoothly to hover. (Be sure rate of descent is less than 300 FPM before airspeed is reduced below 30 KIAS.)

(The rest is omitted)

(3) MR stall

(a) 4-10 (Omitted)

[CAUTION]

(Omitted) *Catastrophic rotor stall could occur if the rotor RPM ever drops below 80 % plus 1 % per 1000 ft of altitude.*

(b) Additional items on Technical Circular Directives (TCD)

Pilots are strongly urged to become familiar with the following information and comply with these recommended procedures.

(1) Main Rotor Stall

Many factors may contribute to main rotor stall and pilots should be familiar with them. Any flight condition that creates excessive angle of attack on the main rotor blades can produce a stall. Low main rotor RPM, aggressive maneuvering, high collective angle (often the result of high-density altitude, over-pitching [exceeding power available] during climb, or high forward airspeed) and slow response to the low main rotor RPM warning horn and light may result in main rotor stall. (The rest is omitted)

(c) Safety Notice

SN-24 LOW RPM ROTOR STALL CAN BE FATAL

(Omitted)

Rotor stall can occur at any airspeed and when it does, the rotor stops producing the lift required to support the helicopter and the aircraft literally falls out of the sky. (Omitted)

When rotor stall happens at heights above 40 or 50 ft AGL, it is most likely to be fatal. (Omitted)

The blade airfoil will stall at a critical angle, resulting in a sudden loss of lift and a large increase in drag.

The increased drag on the blades acts like a huge rotor brake causing the rotor RPM to rapidly decrease, further increasing the rotor stall.

As the helicopter begins to fall, the upward rushing air continues to increase the angle-of-attack on the slowly rotating blades, making recovery virtually impossible, even with full down collective. (Omitted)

As the helicopter begins to fall, the upward flow of air under the tail surfaces tends to pitch the aircraft nose-down.

2.11.4 Descriptions on Manual Book for Rotorcraft

The "Instruction Book for Flying," written jointly by Kenichi Higashi, Masaoki Tsuchiya, Ryuzo Kajikawa and Iwao Nakajima, published by Hobun Shorin Co., Ltd. in 1990, includes the following descriptions: (Excerpt)

(1) Influence of rudder pedal input

7-1-3 Procedures to operate control system

(Omitted)

2. Anti-torque Pedal[*6] (Page 461-462)

(Omitted)

Even a small change in power can appear as a change in the torque on the helicopter. Therefore, when the collective pitch lever is used, the anti-torque pedal must be always applied harmoniously.[*7] *This is a very important point.*

Conversely, when the rudder pedal is applied, the power will be affected. For instance, when the left rudder pedal is applied, power must be increased, while when the right rudder pedal is applied, power must be reduced.

(2) Approach

7-1-1 General Comments

(Omitted)

2. Normal Approach (Page 511)

Commence an approach by way of power gliding with a descent angle of about 8°, and terminates in a hovering over the target.

7-7-3 Normal Approach (Page 513)

If a normal approach is made at a descent angle of 8° from an altitude of 300 ft AGL, the distance from the hovering spot to the starting point of the final approach is approximately 640 m. (The rest is omitted)

3. ANALYSIS

3.1 Flight Crew Qualifications

The captain and the passenger held both valid airman competence certificates and valid aviation medical certificates.

3.2 Airworthiness Certificate

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

3.3 Relations to Meteorological Phenomena

As described in the statement in 2.1.2, it is considered highly probable that the weather was fine and visibility was good at the accident site when the accident occurred.

As described in 2.6 (1), AMeDAS in Kikuchi, Mashiki and Kumamoto located in flat areas

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*6 The "anti-torque pedal" has the same meaning as that for the rudder pedal.

*7 "Operated harmoniously" means a way for appropriately applying the rudder pedal in accordance with the operation of the C/P. When the C/P is lowered, the MR torque drops. Because the helicopter's MR rotates counterclockwise, when seen from above, and because the nose tries to turn to the left in a reaction, the right rudder pedal shall be applied to prevent the nose from deflecting. Similarly, when the collective pitch lever is pulled up, conversely, the left rudder pedal must be applied.

extending to the south from the accident site recorded winds almost twice as fast as the average wind velocity in terms of maximum instantaneous readings on all occasions every 10 minutes before and after the time of the accident. In consideration of the readings of AMeDAS in Kikuchi which is closest to the accident site, it is considered probable that winds were blowing at an average 5 to 6 kt from the southwest with the maximum instantaneous wind velocity estimated at 12 to 13 kt from the southwest, indicating that there were fitful gusts of wind from time to time in relatively weak winds.

3.4 Pilot Flying

As described in 2.7.2 (3), both occupants were able to access to the flight controls, while the captain was seated on the right side and the passenger on the left side.

As described in 2.8,the person at the controls often sustains such injuries as fractured wrists and ankle bones caused by transmitted shock loads through the control system. However, neither occupants sustained such injuries.

Therefore, the pilot flying (hereinafter referred to "the PF") at the time of the accident remained undetermined.

3.5 Aircraft Damage

It is considered highly probable that damage to the Aircraft in all areas affected, as described in 2.3.2 and 2.7.2, had been caused by force applied from the outside under the circumstances mentioned below upon the crash of the Aircraft, because no pre-impact anomalies were seen in the Aircraft.

Judging from the condition of damage to the Aircraft, it is considered highly probable that the Aircraft crashed into the ground from its right side while slightly lowering the nose, with the MR RPM greatly decayed and its fast speed kept horizontally and vertically.

(1) Landing gears and fuselage

It is considered highly probable that the stuck forward cross tube into the bottom of the fuselage, the fractured aft cross tube and the widened skids were all caused by a load applied vertically to the airframe at the time of the crash.

It is considered highly probable that the fracture of the skid on the right side in the joint with the forward strut and its pivoting around the aft joint with the strut was caused by a load applied horizontally when the Aircraft struck the ground from its right side with the nose slightly lowered.

(2) Tail cone

It is considered highly probable that the tail cone was bent downward slightly to the right with a vertical load applied to the airframe when the Aircraft hit the ground from its right side with the nose slightly lowered, and it was fractured and detached as if torn off forward with a horizontal load applied and as a result, the tail cone was thrown away forward to a place about 13 m from the depression which is believed to be the first strike point with the ground.

(3) Engine

a. It is considered probable that the driving belts of the Aircraft had been detached from the clutch assembly due to an impact on the crash. It is also considered probable that an engine over speed running had occurred because the engine became free from the MR and TR load. Judging from the condition of the ignition plugs and the intake and exhaust pipes, it is considered highly probable that after the Aircraft laid sideways in the paddy field, the engine ingested mud and water before it came to a stop.

b. It is considered highly probable that the engine power control system became jammed in the lower part of the left seat, because the floor was instantaneously deformed upon crash. Therefore, it is considered highly probable that the jammed position of the equipment indicates the position of the throttle when the Aircraft crashed.

c. It is considered highly probable that the connector for the utility lines that sends signals to the RPM governor was disconnected at the joint because of applied tension and compression by the impact of the crash.

(4) MR and TR

a. It is considered highly probable that the MR, which became disconnected from the engine by the impact of the crash, was deformed because it struck the paddy field and came to a stop.

As described in 2.7.2 (3), damage to the MR was limited, and rugged cracks or damage often observed under high speed impact condition were not seen at all. Therefore, it is considered highly probable that the MR RPM was fairly low at the time of the crash and the rotation of the MR came to a stop immediately after the Aircraft hit the ground.

b. As described in 2.7.2 (3) d, the fractured MR pitch links did not show any signs of fatigue rupture. Therefore, it is considered highly probable that the damage to the area came to a final phase of fracture in a relatively short period of time because of a load which is believed to have been temporarily applied.

Accordingly, it is considered probable that the fracture of the MR pitch link occurred instantaneously because it was exposed to impact load upon the crash.

c. As described in 2.7.2 (3) e, it is considered highly probable the left rudder pedal was applied to the maximum position at the time of the crash.

3.6 Engine Control at Time of Accident

As described in 2.7.2 (3) c, the C/P of the Aircraft was almost in the full down position at the accident site, while as described in 2.10.2 (2) b, this position was in excess of the engine RPM limit. As described in 3.5 (4) a, this fact was not consistent with the condition of the MR, whose RPM is estimated to have been fairly low at the time of the crash.

Generally speaking, it is considered that pilots tend to try to instantaneously increase the lift by pulling up the C/P before the ground strike. So, it is considered probable that the possibility is slim that the C/P of the Aircraft was almost in the full down position until the time of the crash.

In view of the above mentioned, it is considered probable that as described in 2.10.2 (2) c just before the crash, the C/P was pulled up to a position where the Aircraft was able to hover just above the ground but that the C/P was lowered almost to the full down position because of the impact of the crash.

3.7 Situation until the Time of the Accident

3.7.1 Approach Course

As described in 2.1.1, the Aircraft was approaching toward Kamou Helipad roughly in the true course of 100° from the west-northwest, according to the portable GPS record. This is a course that leads straight to the vicinity of the paddy field north of Kamou Helipad.

It is considered probable that the Aircraft was trying to land toward the south, judging that a southern wind was blowing at Kamou Helipad based on the weather condition of the day.

3.7.2 Final Approach Course

According to the statements in 2.11.2, when the Aircraft landed toward the south in the past, it is considered probable that the Aircraft flew an eastward final approach course parallel to and south of City Road 121 and the utility lines which runs east to west about 170 m north of the Helipad, rather than flying final approach course through the approved approach area above the housing area located north of Kamou Helipad. In these flights, it is considered probable that the aircraft terminated approach to a hovering over the paddy field orienting to the east after reducing the altitude and the airspeed, followed by the change of its direction to the south, air taxi and landing.

As described in 2.1.1, it is considered highly probable that the Aircraft was approaching eastwardly at the time of the accident, as in the past, without using the approved final approach course through the approved approach area. But it is considered highly probable that unlike the past flights, the Aircraft approached on the north side, not the south side, of the utility lines and as a result, the Aircraft had to cross them before reaching the helipad.

Regarding the fact that the Aircraft was approaching eastwardly without flying on a final approach course through the approved approach area, it is considered somewhat likely that the Aircraft avoided a flight over the housing area north of City Road 121 for noise abatement, but it remains undetermined exactly why the Aircraft did so.

3.7.3 Situation from Final Approach to Crash

(1) Approach angle

According to an analysis of the final approach course based on the GPS data as described in 2.1.1, it is considered highly probable that the Aircraft commenced a final approach about 900 m west-northwest of Kamou Helipad at an altitude of 300 ft AGLH and it continued the approach at a constant approach angle of about 5° until reaching the middle point of the final approach at an altitude of about 150 ft AGLH, over the vicinity of utility lines.

It is estimated that in order for the Aircraft to transfer to a hover over a place north of the helipad, as in the past, the approach angle should be increased to about 8° before traveling about 330 m to the hovering position.

As described in 2.11.4 (2), this was an approach angle which is generally used for helicopters.

(2) Approach speed

As described in 2.1.1, the Aircraft passed the commencing point of the final approach at an altitude of about 300 ft AGLH at about 65 kt GS and after that, its GS became about 63 kt at an altitude of about 150 ft AGLH over the vicinity of utility lines as the middle point of the final approach. These figures are estimated to be equivalent to airspeeds of about 63 kt and 61 kt, respectively, assuming that winds around the accident site were blowing at an average of 5 to 6 kt from the southwest.

The commenced airspeed of about 63 kt for the final approach was normal, as it was in the neighborhood of an airspeed of 60 kt as registered in the flight manual for the Aircraft as described in 2.11.3 (2).

Meanwhile, as described in 2.10.2 (1) a, it is considered probable that the airspeed of about 61 kt at the middle point of the final approach should have been reduced to about 30 kt. According to Figure 4 "Comparative Table with Past Flight Data of the Aircraft " the average speed at the places of 150 ft AGLH was calculated at about 31 kt in all flights except for one occasion in which an approach was made toward A Airport at a high speed.

But it is considered highly probable that the Aircraft little decelerated and its speed was maintained at about 61 kt, about twice as fast as the normal speed, until the middle point of the final approach. But the reason remained undetermined.

(3) Situation at the time of crash

a. As described in 2.1.1, it is considered highly probable that after passing the middle point of the final approach at an altitude of about 150 ft AGLH, the Aircraft deflected to the left and flew above the utility lines while descending to an altitude of about 110 ft AGL. Although it was deflecting to the right, the rate of descent gradually increased after passing an altitude of about 90 ft AGLH, and the Aircraft crashed after crossing over the utility lines (40 ft AGL) and the road diagonally at an altitude of about 60 ft AGLH.

b. As described in 2.1.2 (2), the witness stated that the Aircraft fell in a sharp angle while keeping its speed almost unchanged after flying beyond the road. Therefore, it is considered highly probable that the rate of descent rapidly increased from an altitude of around 60 ft AGLH.

c. Based on the factors mentioned below, it is considered highly probable that the Aircraft continued to approach at a constant approach angle until the final approach middle point, but then the MR RPM decayed and from around an altitude of about 100 ft AGLH where the rate of descent is believed to have begun to increase, the MR RPM decayed rapidly and the stall of the MR set in, as described in 2.11.3 (3).

1. The rate of descent rapidly increased before the crash.
2. As described in 3.5 (4), it is estimated that the MR RPM had fairly dropped when the Aircraft crashed.
3. As described in 2.1.2, the witness stated that the Aircraft appeared to have fallen while turning to the right with its nose slightly lowered. (As described in 2.11.3 (3) c, when the MR stalls, the helicopter loses the lift to support it and falls, while the upward flow of air under the tail surface works to pitch the helicopter nose-down. It is considered probable that even if the left rudder pedal was applied after the TR function declined due to a low TR RPM, the nose deflection to the right due to the anti-torque of the MR cannot be fully stopped.)

d. It is considered highly probable that the Aircraft failed to reduce its descent rate and crashed on the ground with a high rate of descent, because the Aircraft finally became uncontrollable due to the catastrophic stall of the MR and resultant loss of almost entire lift.

3.7.4 Situation of Low MR RPM and MR Stall

It is considered that a go-around should be made when the airspeed far surpasses the normal level at around the middle point of the final approach. But according to the statements by the witnesses and the data on the portable GPS, and there was no indication that the Aircraft tried to go around at this point, it is considered probable that the Aircraft continued the landing.

(1) Landing procedures

For landing under this condition, the Aircraft had to transfer to a hovering by quickly decelerating from twice the normal airspeed of about 61 kt at the middle point, while traveling a usual distance of about 330 m.

In this case, it is considered probable that the Aircraft had to increase the rate of descent by further lowering the C/P from the descending position followed by a nose-up attitude for a quick reduction airspeed. But, as described in 2.10.2 (1) b, this is quite different from the normal maneuver and it is believed to be difficult.

As indicated in Figure 4 “Comparative Table with the Past Flight Data of the Aircraft ,” an analysis of the flight data for the approach to A Airport, in which an approach was made at a high speed, as same as the case of the accident, showed that the Aircraft traveled a distance of about 600 m, about twice as long as the normal distance, before transferring to a hovering from the speed of about 58 kt, as twice as fast as the normal speed, at the middle point.

(2) How a low MR RPM condition occurred

a. It is considered somewhat likely that the PF further pulled down the C/P from the descent position at around the middle point of the final approach, at an altitude of about 150 ft AGLH over the vicinity of utility lines.

b. As described in 2.1.1 and Figure 1 “Estimated Flight Route,” it is considered highly probable that after passing the middle point of the final approach at 14:00:51, the Aircraft deflected to the left from the course which runs diagonally over the utility lines around 14:00:53, and then flew above the utility lines.

c. As described in 3.3, a maximum instantaneous wind nearly twice as fast as the average wind from the right was observed then around the accident site. Therefore, it is considered somewhat likely that the deflection to the left from the course reflects an influence of the wind that drifted the Aircraft to the left (to the leeward).

As described in 2.10.2 (1) c, it is considered somewhat likely that yawing to the right occurred due to the weathercock effect following the influence of a maximum instantaneous wind from the right and that the PF applied the left rudder pedal to deal with this to maintain the attitude.

d. As described in 2.11.4 (1), when the left rudder pedal is applied, the power must be added to counter the increased load on the TR.

It is considered somewhat likely that the C/P was lowered further than a normal descent (The throttle position should be around the idle position) when the left rudder was applied. It is considered somewhat likely that the engine and MR RPM dropped temporary, when the left rudder pedal was applied hard with the power condition close to the idle position, the required power exceeded the available power as a result of an increased load on the TR. Then, it is considered somewhat likely that the aircraft began to descend more rapidly.

(3) How the MR stalled

a. As described in Figure 1 “Estimated Flight Route,” it is considered somewhat likely that when the Aircraft was flying above in the vicinity of the utility lines after passing the middle point, the PF had concluded that the Aircraft would come down very close to the utility lines if it continues to descend rapidly and in an attempt to avoid this, he pulled up the C/P, which was earlier pulled down, again to a power position with which 1 m hovering can be made as described in 2.10.2 (2) c and on this occasion, he further applied the left rudder pedal as an usual control.

b. It is considered somewhat likely that following an increase in the load with the additional left rudder input, combined with a substantial increase in the load due to over-pitching as described in 2.11.3 (3) b by pulling up the C/P under the low RPM condition, the required power exceeded the available power and the angle-of attack of the MR blades reached a stall angle developing a stall, the MR RPM rapidly decayed, eventually leading to a catastrophic stall with the MR lift lost almost entirely resulting in a uncontrollable aircraft condition.

Therefore, it is considered somewhat likely that the MR RPM at the time of the accident decayed to a level where a catastrophic rotor stall can occur, as described in [CAUTION] in 2.11.3 (3) a, which is estimated at below about 82 % at a density altitude of about 2,200 ft for the day of the accident.

(See Figure 6 Chain of Events)

3.8 Prevention of Reoccurrence of Similar Accidents

Measures mentioned below are considerable preventive measures for a reoccurrence of similar accidents.

(1) Stick to the basics

a. Selection of final approach course

The final approach course must be selected after fully grasping the weather condition. Therefore, when using temporary helipads and other places where the latest weather information cannot be obtained by radio communications or other means, it is necessary to consider that the wind condition on the ground must be confirmed beforehand by observing a windsock or other things indicative of wind direction during a fly-over and then, a final approach course through the approved approach area must be selected.

b. Speed control

In order to transfer to a stable hovering over a target after descending on a certain approach angle, it is necessary to reduce airspeed corresponding to descending altitude.

c. Go-around

When the flight parameters go wild while approaching or the attitude becomes unstable, or any other unusual condition occurs, it is necessary that a go-around procedure must be taken without hesitation.

(2) Responses to cross winds

Generally speaking, a wind correction in approach for landing is made by taking an upwind crab angle to counter drifts before the start of deceleration. On and after the deceleration, MR rotating plane is tilted to upwind to counter the drift while maintaining approach direction by applying downwind rudder. But in case where the attitude becomes unstable amid fitful gusts, landing must be made within a feasible operational range, such as decelerating into the wind, in view of the flight performances.

(3) Prevention of MR stall in low RPM

For helicopters which have difficulty in recovering from a stall, it is extremely important not to drop the MR RPM excessively

The engine and MR RPM must be carefully monitored during flight and at the same time, any control that may decay RPM should be avoided.

In case of a low RPM, this must be quickly recovered so that a catastrophic stall should be avoided. Therefore, recovery procedures from a low RPM must be routinely reconfirmed for familiarization so that necessary actions can be taken at any time.

4. Conclusions

4.1 Findings

(1) As far as the winds are concerned, it is considered probable that there were fitful gusts accompanied with a maximum instantaneous wind about twice as fast as the average wind from the southwest.

(2) PF at the time of the accident remained undetermined between the captain and the passenger.

(3) It is considered highly probable that there were no pre-impact anomalies for the Aircraft in view of the condition of damage and that the Aircraft crashed in to the ground from its right side while slightly lowering the nose, with the MR RPM greatly decayed and without its horizontal and vertical speed reduced.

(4) The Aircraft approached eastwardly without flying over the approved approach area, but the reason remained undetermined.

(5) It is considered highly probable that the Aircraft made little deceleration until the middle point of the final approach, maintaining its speed about twice as fast as the normal speed. But the reason remained undetermined.

(6) It is considered highly probable that the Aircraft crashed into the ground with a high rate of descent rate without being able to reduce airspeed because its MR RPM decayed on and after the middle point resulting in the uncontrollable conditions due to a loss of most of its MR lift by a catastrophic stall.

(7) It is considered somewhat likely that in a low power condition with the C/P greatly pulled down in an attempt to land by quick deceleration from a faster than usual speed, PF applied the left rudder pedal hard to correct right yaw in cross winds, and as a result, the Aircraft's required power surpassed the available power by the increase of the load, causing its MR to develop a low RPM temporary.

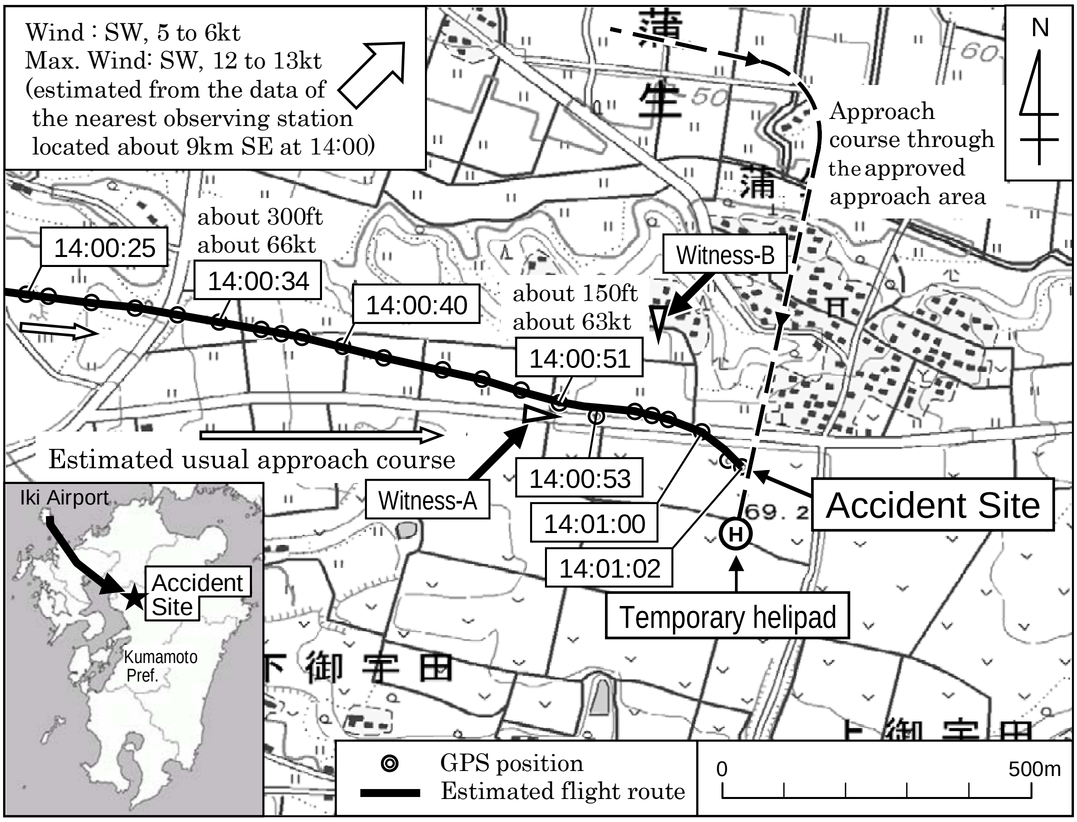
(8) It is considered somewhat likely that because the C/P was pulled up to avoid proximity with the utility lines in a low MR RPM condition, leading to a substantially increased load and the condition where the required power exceeding the available power, followed by the MR's angle-of-attack reaching a stall angle, rapid decay of the MR RPM, loss of almost entire lift of MR and eventually a catastrophic stall making the Aircraft uncontrollable.

4.2 Probable Causes

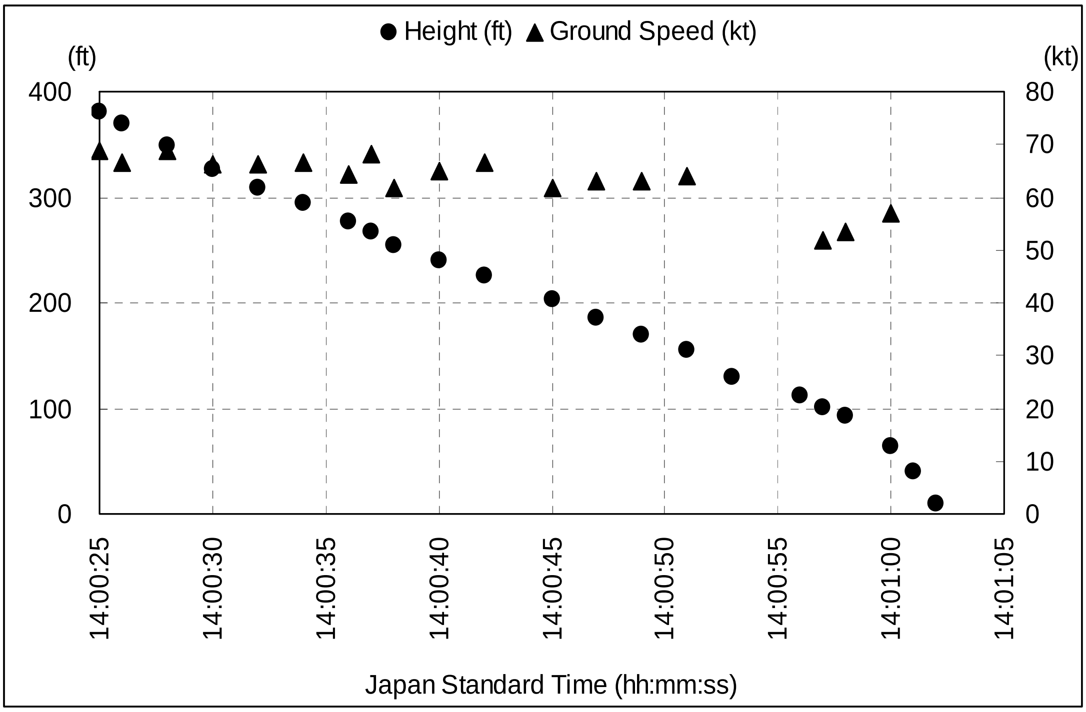
It is considered highly probable that the Aircraft fell into an uncontrollable condition in its final approach in this accident caused by a catastrophic MR stall with its lift lost almost entirely resulting in the crashed into the ground with a high rate of descent without reducing its fast speed, causing the airframe to be destroyed and the occupants to be killed.

As to the uncontrollable situation caused by the catastrophic stall out of the entire loss of MR lift, it is considered somewhat likely that the PF's pull-up of the C/P in a low MR RPM condition lead to a substantially increased load and the condition where the required power exceeded the available power, followed by the MR's angle-of-attack reaching a stall angle, and rapid decay of the MR RPM.

Figure 1 Estimated Flight Route



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



Height above helipad and corresponding ground speed estimated from GPS recorded data.

Figure 2 Accident Site Layout

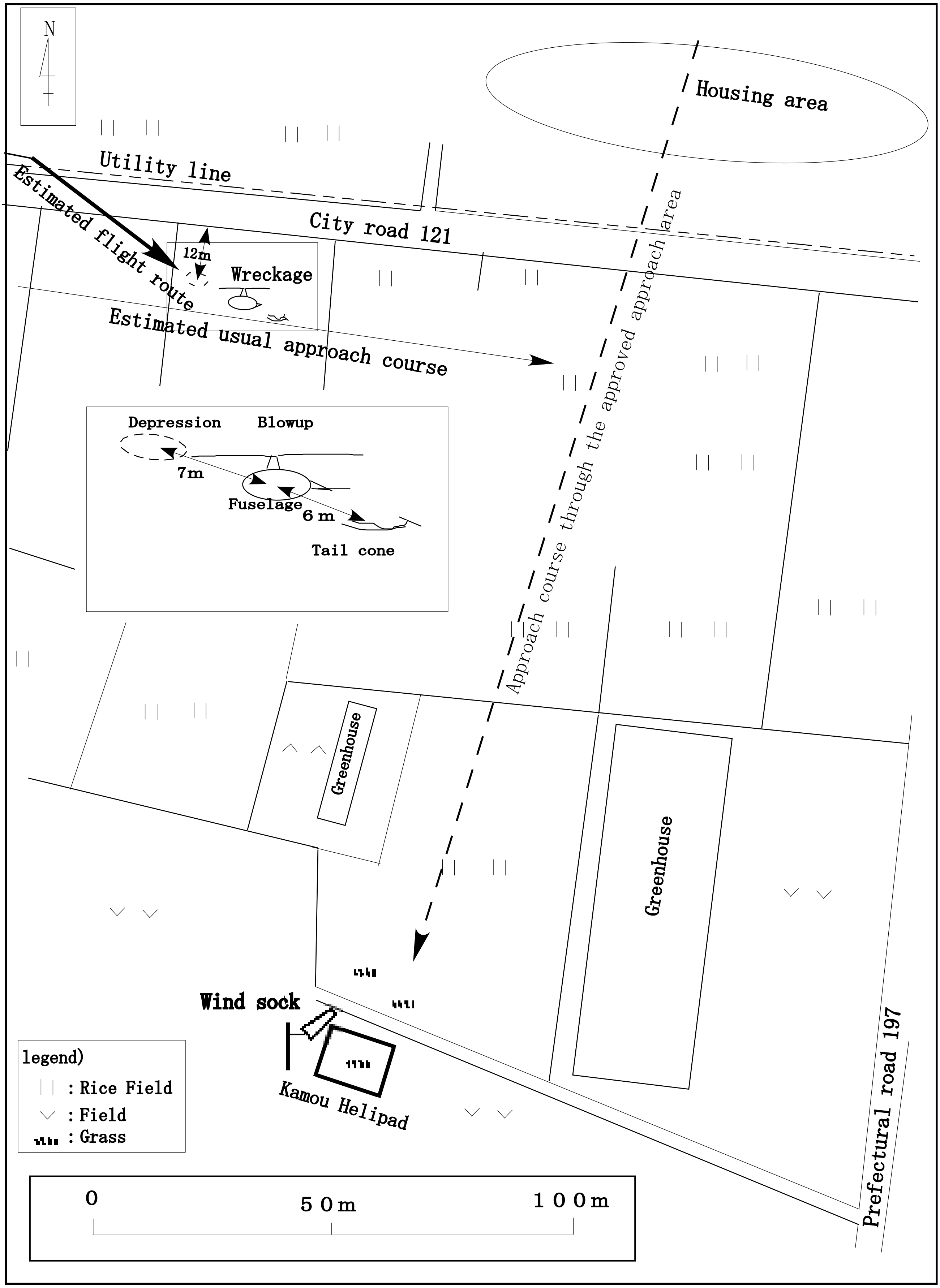


Figure 3 Three Angle View of Robinson R22 Beta

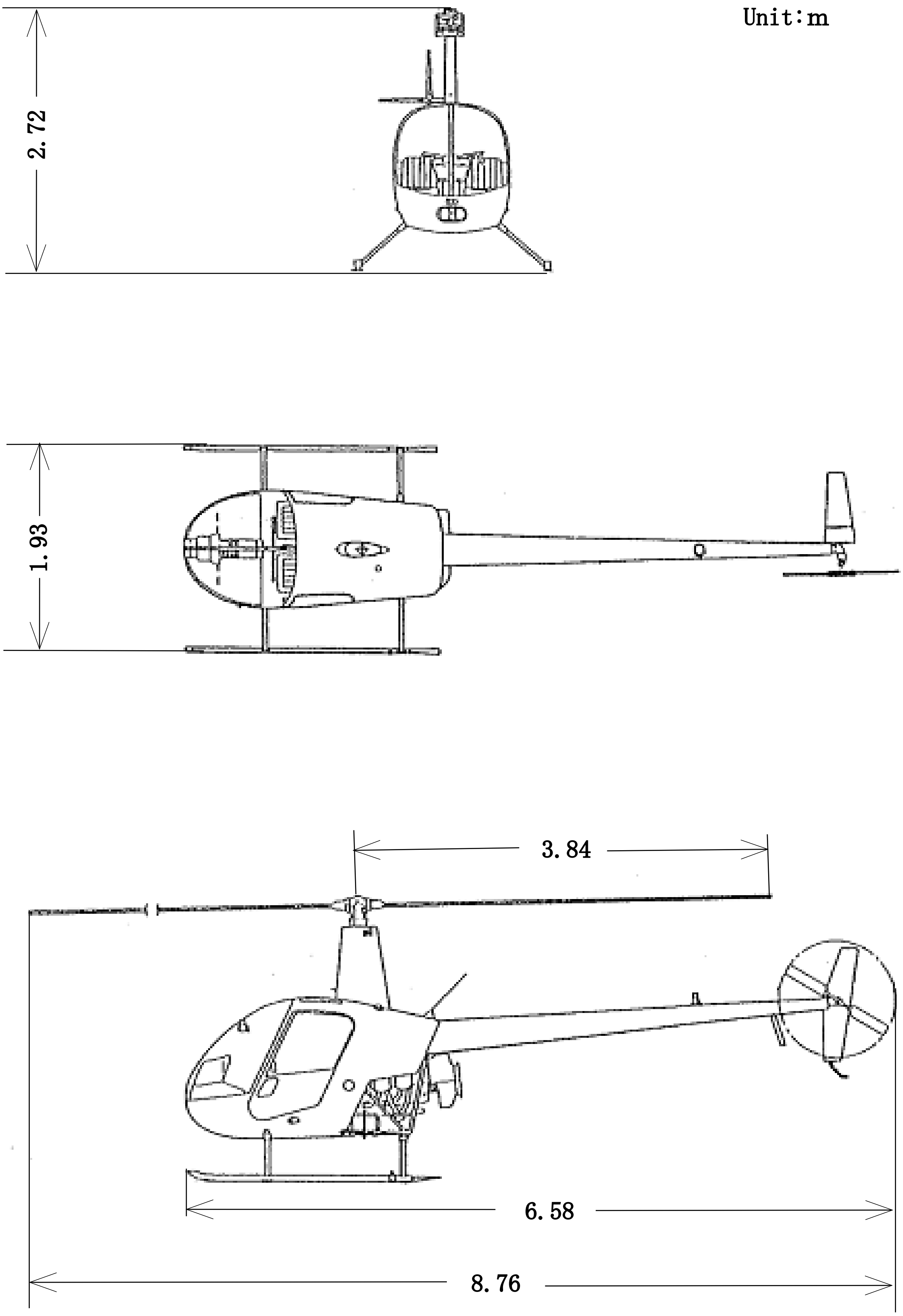


Figure 4 Comparative table with the past flight data of the aircraft

		1	2	3	4	5
AGL	300ft	64kt	56kt	30kt	40kt	19kt
	200ft	48kt	45kt	23kt	32kt	17kt
	150ft	35kt	39kt	22kt	30kt	15kt
	50ft	20kt	19kt	9kt	17kt	8kt
	15ft	1kt	5kt	3kt	11kt	4kt
ALD from 150ft		APPROX 180m	APPROX 300m	APPROX 200m	APPROX 300m	APPROX 200m
Destination		Helipad				
Remarks						

		6	7	8	9	１０
AGL	300ft	40kt	73kt	66kt	43kt	65kt
	200ft	32kt	55kt	61kt	40kt	63kt
	150ft	25kt	43kt	58kt	36kt	63kt
	50ft	13kt	32kt	46kt	33kt	—
	15ft	8kt	25kt	27kt	20kt	—
ALD from 150ft		APPROX 約 200m	APPROX 約 320m	APPROX 約 600m	APPROX 約 400m	APPROX 330m (Estimated)
Destination		Helipad		A airport	B airport	Helipad
Remarks				HSA		Accident

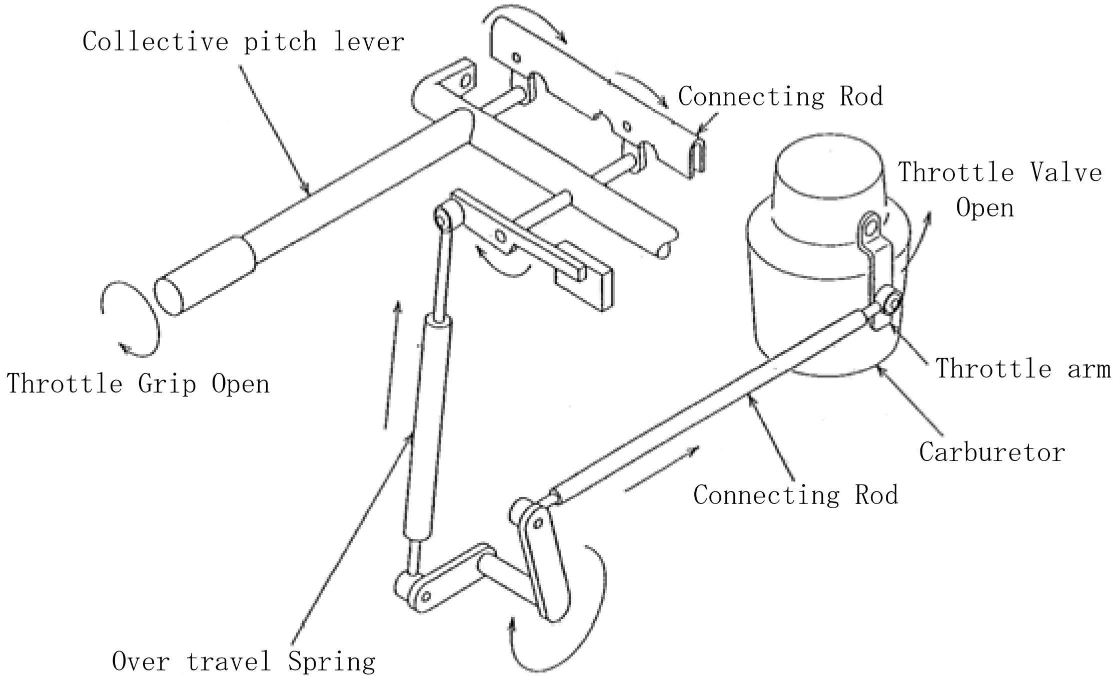
Ground speeds and heights above helipad were estimated from GPS recorded data.

ALD: Approach and Landing Distance

HSA: High Speed Approach

Figure 5　The Throttle Valve Control

Control with the throttle grip



Control with the correlation mechanism

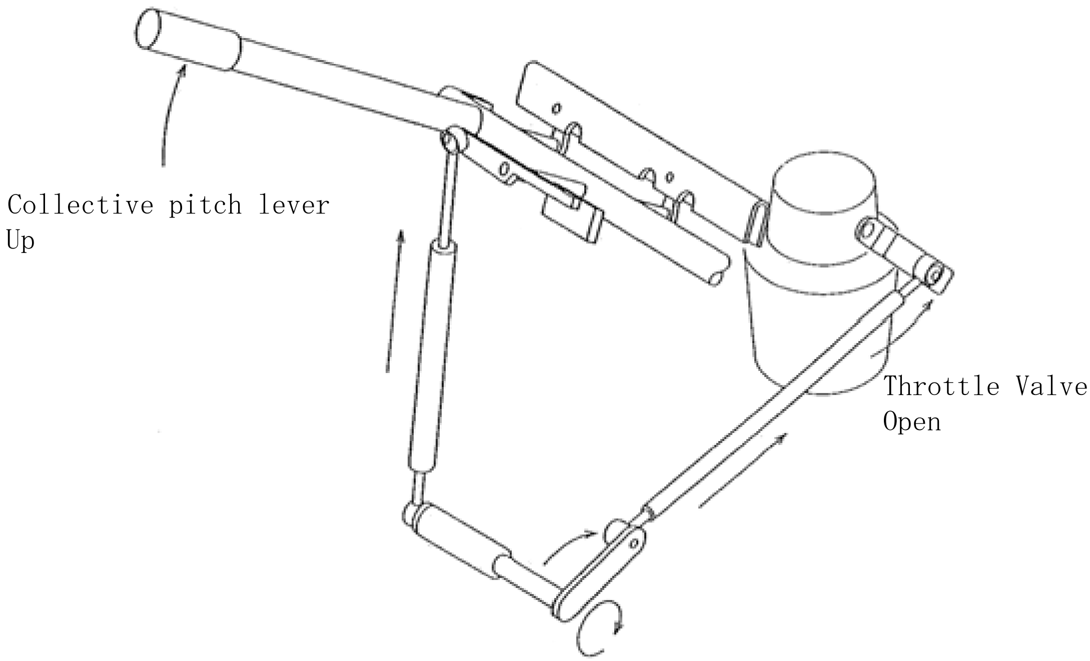


Figure 6　Chain of Events

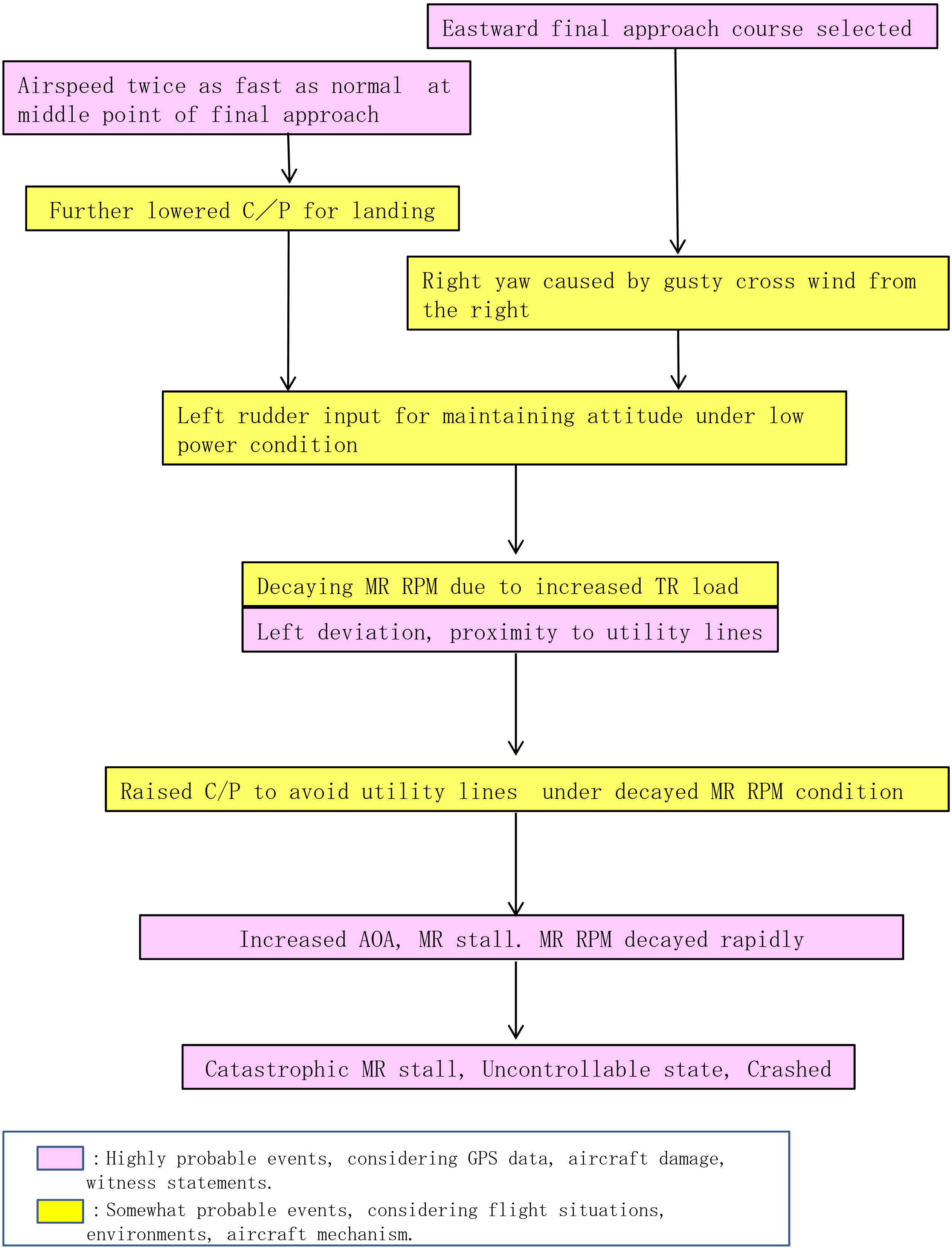


Photo 1　Accident Site

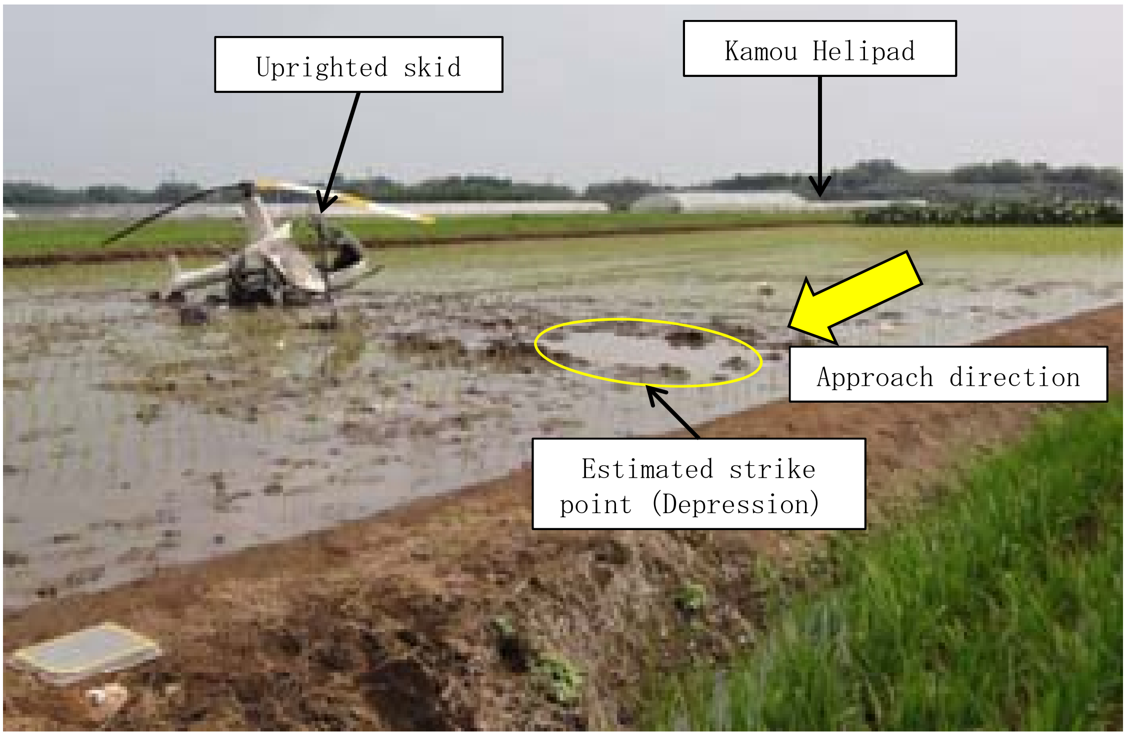
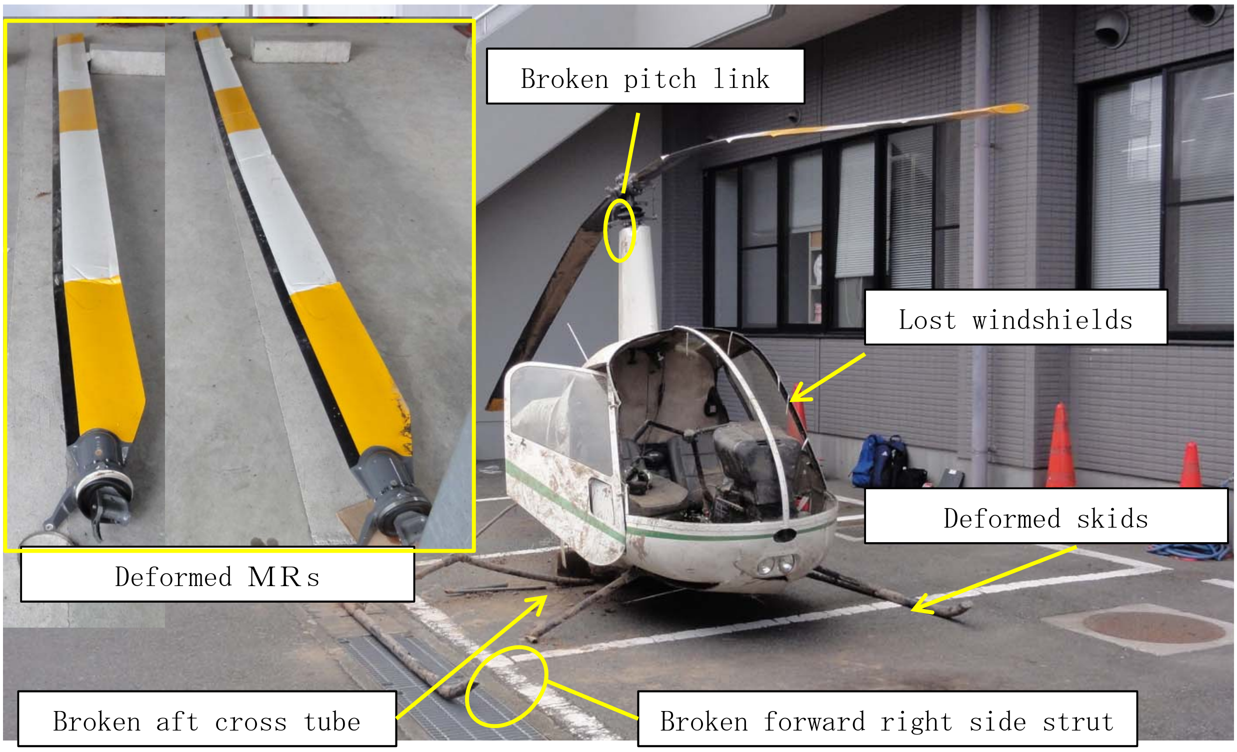


Photo 2 Accident Aircraft
(Overview)



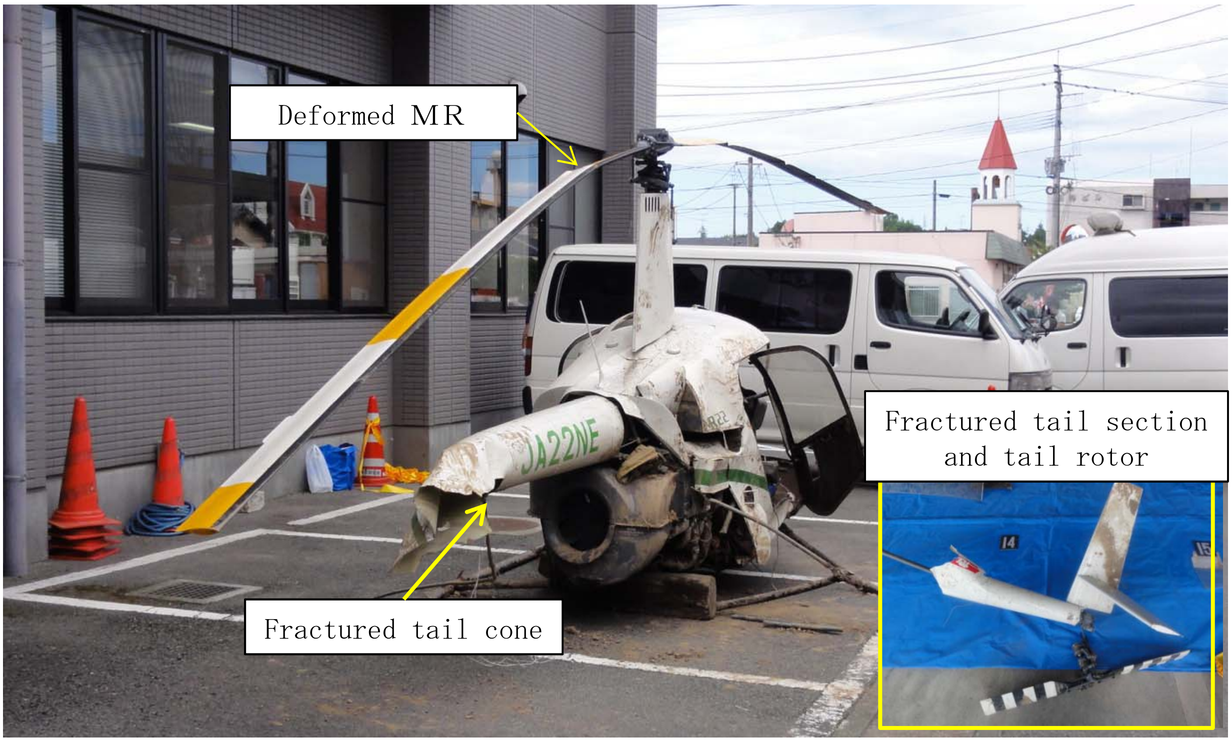
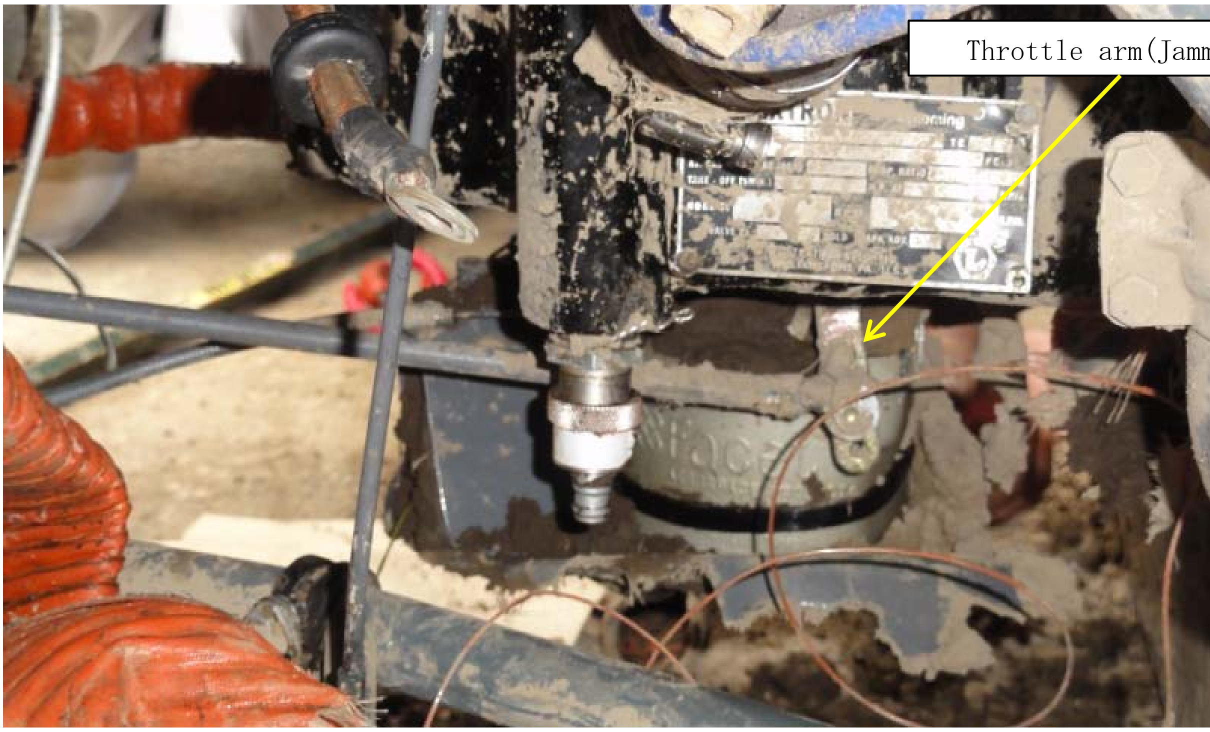


Photo 3 Accident Aircraft
(Engine)



(Carburetor)

(Cylinder)