AIRCRAFT ACCIDENT INVESTIGATION REPORT

AIRCRAFT DAMAGE DUE TO ROLLOVER DURING LANDING

PRIVATELY OWNED

ROBINSON R22 BETA (ROTORCRAFT), JA7875

TOYAMA CITY, TOYAMA PREFECTURE

AT ABOUT 15:32 JST, MAY 3, 2023

January 24, 2025

Adopted by the Japan Transport Safety Board

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

1. PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident	On Wednesday May 3, 2023, a privately owned Robinson R22 Beta, JA7875, took off from the paved area in front of the hangar at the Yamafuji Temporary Operation Site (hereinafter referred to as "the Old Operation Site) in Toyama City, Toyama Prefecture for a familiarization flight. After a round trip to Noto Airport, the helicopter rolled over due to a failure of the directional control while landing at the Old Operation Site, resulting in damage to the airframe. On board the helicopter were two people, a pilot, and a passenger, but neither suffered injuries.
1.2 Outline of the Accident Investigation	On May 3, 2023, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator to investigate the accident. An accredited representative and an advisor of the United States of America, as the State of Design and Manufacture of the helicopter and the engine involved in this accident, participated in the investigation. Comments on the draft Final Report were invited from parties relevant to the cause of the accident and the Relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the helicopter's flight plan, the statements of the pilot and the passenger, as well as the video from the surveillance cameras, the history of the flight is summarized as below:

	A privately owned Robinson R22 Beta, JA7875, for familiarization flight, was scheduled to make a round trip from the Old Operation Site to Noto Airport as shown in Figure 1. On board the helicopter, were the pilot in the right seat and the passenger (who had a certificate of competency to fly the helicopter, but not a flight instructor related certificate) in the left seat. On May 3, 2023, the helicopter took off from the Old Operation Site at about 12:20 (JST: UTC+9hr, unless otherwise stated, all times are indicated in JST on a 24-hour clock) and landed at Noto Airport at 13:00. The helicopter then took off from Noto Airport at 14:54 and flew to the Old Operation Site. At 15:32, as shown in Figure 2, as the helicopter approached the Old Operation Site from its south side, it encountered a strong westerly wind and lost directional control shortly before touchdown, rolling over with its leaning against the grapevine shelves on the east side. (1) Statement of the Pilot The pilot was aware that the wind was strong, having been informed by the Airport mobile communication station (Noto Radio) that the maximum wind velocity was 25 kt, with an average wind velocity of 11 kt at the time of take-off from Noto Airport at 14:54. After taking off from Noto Airport, the helicopter followed the flight plan, approaching to the Old Operation site from the south to avoid the power lines. In addition, as the helicopter flew over the west side of the Old Operation Site, the wind direction indicator swung up and down, the pilot was aware that the wind around the Old Operation Site was strong. Aware of the strong wind, the pilot slowly approached the hangar with its nose direction pointing towards it, but the helicopter's aft fuselage swayed slightly just short of the Old Operation Site. Immediately afterwards, as the helicopter entered the Old Operation Site, the nose direction swung sharply to the left, therefore, the pilot tried to recover by applying the right pedal[*1] to stop the swing, but unable to control the attitude, and the steel wires of the grapevine shelves wrapped around the main rotor, causing the helicopter to roll over, leaning against the grapevine shelves. Besides, the pilot was aware that the passenger in the left seat had touched the cyclic pitch control[*2] (hereinafter referred to as "the Cyclic") after the pilot had applied the right pedal but did not recognize that the nose direction had spun around once. (2) Statement of the Passenger The pilot in the right seat controlled the helicopter for the round trip to Noto Airport. When they flew over the west side of the Old Operation Site, the passenger watched the wind near the ground, felting that the wind, which the passenger had never encountered, was blowing watching the wind near the ground. As the helicopter, controlled by the pilot, approached the Old Operation Site, the wind blew from the left and the helicopter's nose direction swung sharply to the left, then the helicopter spun around to the right and began to

*1 "Pedals" refer to the tail rotor pedals, which in a single rotor helicopter control the aircraft's heading by increasing or decreasing the thrust of the tail rotor. On the R22 Beta helicopter, to maintain heading, if the thrust of main rotor increase, the left pedal is input to increase the antitorque, and if the thrust of main rotor decreases, the right pedal is input to decrease the antitorque.

* 2 "Cyclic pitch control" is one of the control devices used in helicopters. It is a device that is mainly operated to tilt the helicopter's attitude to control it.

move forward, when the passenger operated the Cyclic to assist the pilot. However, when the passenger found, the helicopter had rolled over, while not knowing how the helicopter moved. In addition, the passenger did not know the helicopter's nose direction had spun around once.

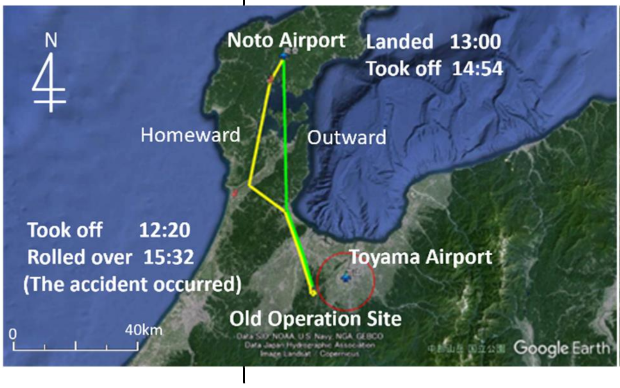


Figure 1: Estimated Flight Route of the Helicopter (Based on the flight plan and the statement of the pilot)

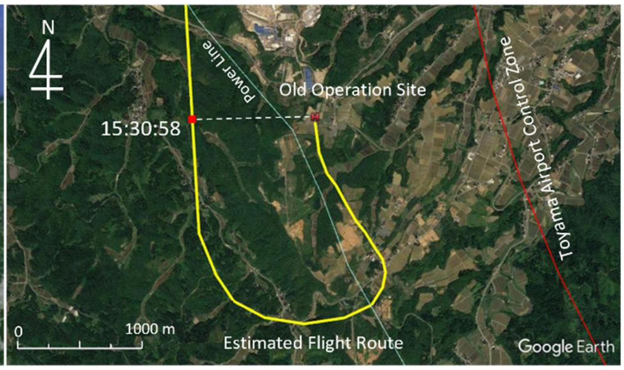


Figure 2: Estimated Flight Route before the Helicopter's Rollover (Based on the statement of the pilot)

This accident occurred at 15:32:53, on May 3, 2023, in the vicinity of about 11 km southwest of Toyama Airport, Toyama Prefecture (36° 37' 34" N, 137° 04' 17" E).

2.2 Injuries to Persons

None

2.3 Damage to the Aircraft

(1) Extent of damage: Substantially damaged

(2) Damage to parts of the Helicopter

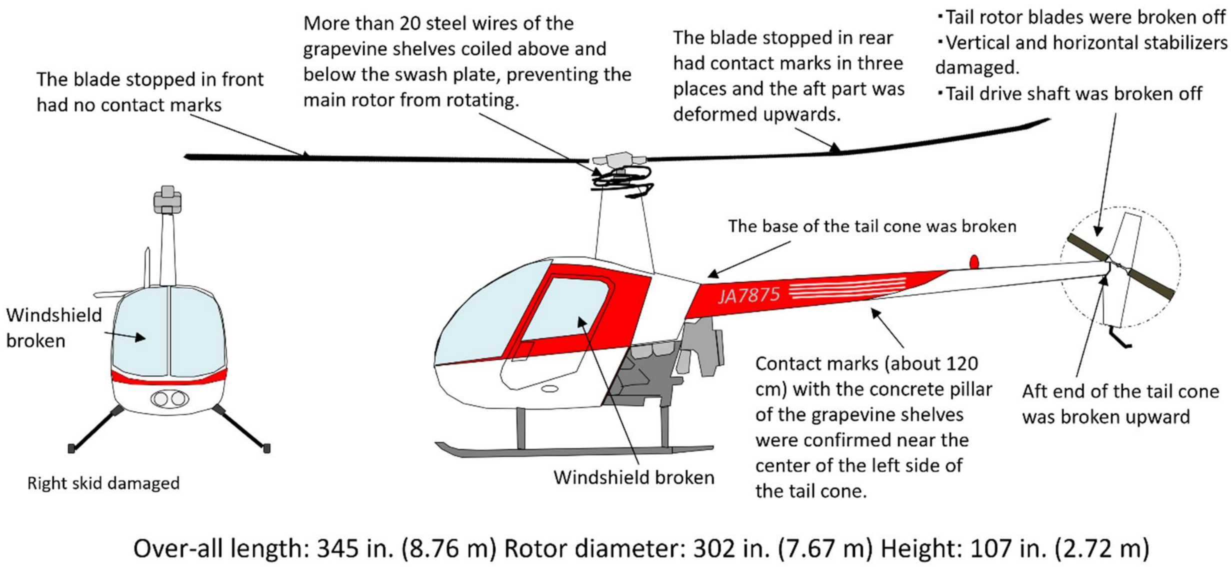


Figure 3: Damage to the Helicopter

Figure 4: Rollover Situation of the Helicopter

a Fuselage: (Figure 3 and Figure 4)

(a) Cockpit right front windshield and the left door window were broken.

(b) The base of the tail cone was broken.

(c) Contact marks (about 120 cm) with the concrete pillar of the grapevine shelves were confirmed near the center of the left side of the tail cone.

(d) The aft end of the tail cone was broken upward.

(e) Vertical and horizontal stabilizers damaged.

b Main Rotor System

(a) More than 20 steel wires of the grapevine shelves coiled above and below the swashplate, and the collective pitch control[*3] (hereinafter referred to as “the Collective”) was stopped to its uppermost position, preventing the main rotor from rotating freely. (Figure 3 to Figure 5).)

(b) The blade that stopped in front had no contact marks, while the blade that stopped in rear had contact marks in three places and the aft part was deformed upwards.

c Tail Rotor System

(a) The tips of the tail rotor blades were broken off and scattered about 30 m the west of where the helicopter rolled over. (Figure 6 and Figure 9)

(b) The tail drive shaft was broken off.

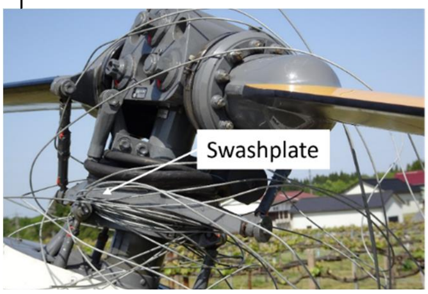
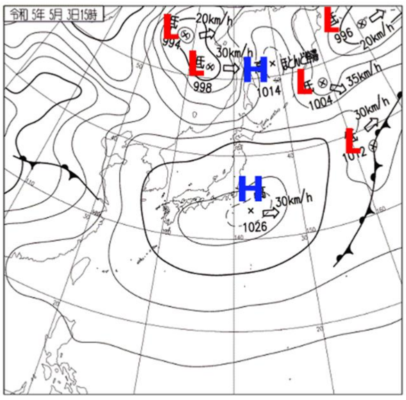


Figure 5: Steel Wires coiled around on the Swashplate

Figure 6: Broken Tail Rotor Blades

*3 “Collective pitch control” is one of the control devices for helicopters. It is a system that controls vertical movement by operating a lever up and down to increase or decrease the thrust of the main rotor.

2.4 Personnel Information	(1) Pilot: Age 57 Private pilot certificate (Rotorcraft) July 6, 1995 Specific pilot competence Expiry of practicable period for flight April 23, 2025 Rating for Single-piston engine (Land) July 6, 1995 Class 2 aviation medical certificate Validity: March 1, 2024 Total flight time 321 hours 46 minutes Flight time in the last 30 days 2 hours 41 minutes Total flight time on the type of the aircraft 321 hours 46 minutes Flight time in the last 30 days 2 hours 41 minutes (2) Passenger: Age 75 Private pilot certificate (Rotorcraft) July 6, 1995 Specific pilot competence Expiry of practicable period for flight April 23, 2025 Rating for Single-piston engine (Land) July 6, 1995 Class 2 aviation medical certificate Validity: August 24, 2023 Total flight time about 1,300 hours 00 minute Flight time in the last 30 days 24 hours 36 minutes Total flight time on the type of the aircraft about 1,300 hours 00 minute Flight time in the last 30 days 24 hours 36 minutes
2.5 Aircraft Information	Aircraft type: Robinson R22 Beta Serial number: 1915 Date of manufacture: August 23, 1991 Certificate of airworthiness: No. Dai-2022-131 Validity: June 23, 2023 Total flight time: 5,282 hours 24 minutes When the accident occurred, the weight and the position of the center of gravity of the helicopter were within the allowable range.
2.6 Meteorological Information	(1) General Weather Conditions According to the observation of the Japan Meteorological Agency, the main island of Japan was covered by a moving high-pressure system in a wide area, and it was clear and calm, but in the afternoon, a slightly strong prevailing wind blew from north to northwest in the Toyama region. (2) Aeronautical weather observations for Toyama Airport, located about 11 km northeast of the accident site, around the time of the accident were as follows:  **Figure 7: Surface Analysis Chart (As of 15:00 on May 3, 2023)** 15:00 Wind direction: 010°, Wind velocity: 9 kt, CAVOK*4 Temperature: 24°C, Dew point: 8°C, Altimeter setting (QNH): 30.19 inHg

*4 "CAVOK" stands for Ceiling And Visibility OK and refers to weather conditions where visibility is good and there are no low clouds.

	16:00 Wind direction: 300°, Wind velocity: 9 kt, Wind direction fluctuation 250° to 320°, CAVOK Temperature: 24°C, Dew point: 8°C, Altimeter setting (QNH): 30.19 inHg (3) According to the wind direction indicator installed at the Old Operation Site, the accident site, the changes in wind direction and wind velocity immediately before the accident as shown in Figure 8. (This was created by confirming the movement of the wind direction indicator captured on surveillance camera video.)

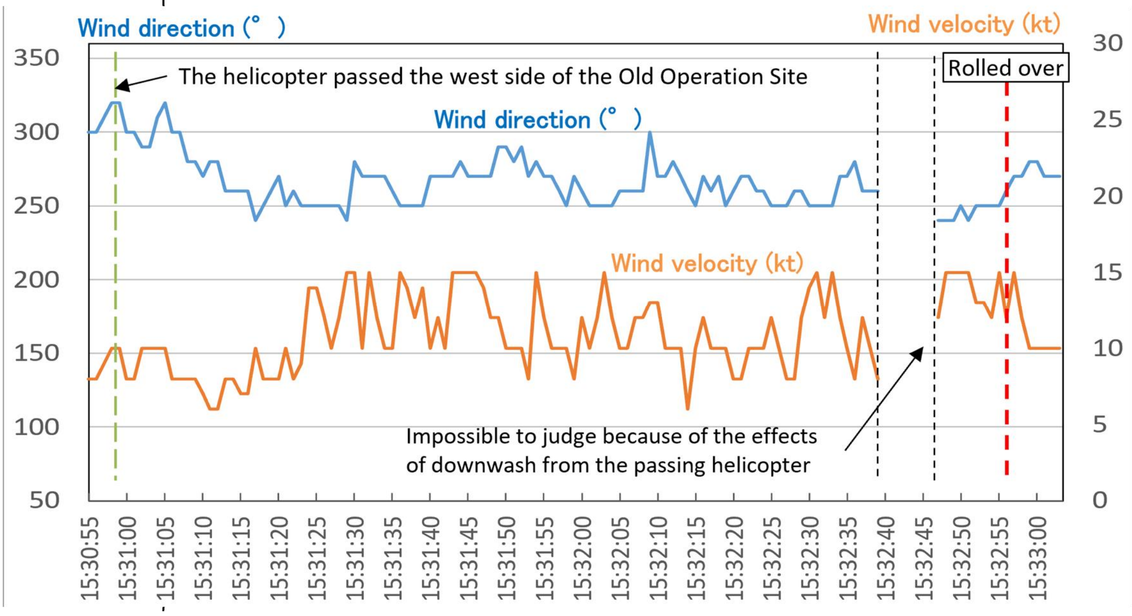


Figure 8: Changes in Wind Direction and Wind Velocity as Measured by of the Wind Direction Indicator near the Old Operation Site

2.7 Accident Site	(1) Location of the Accident Site Ortho*

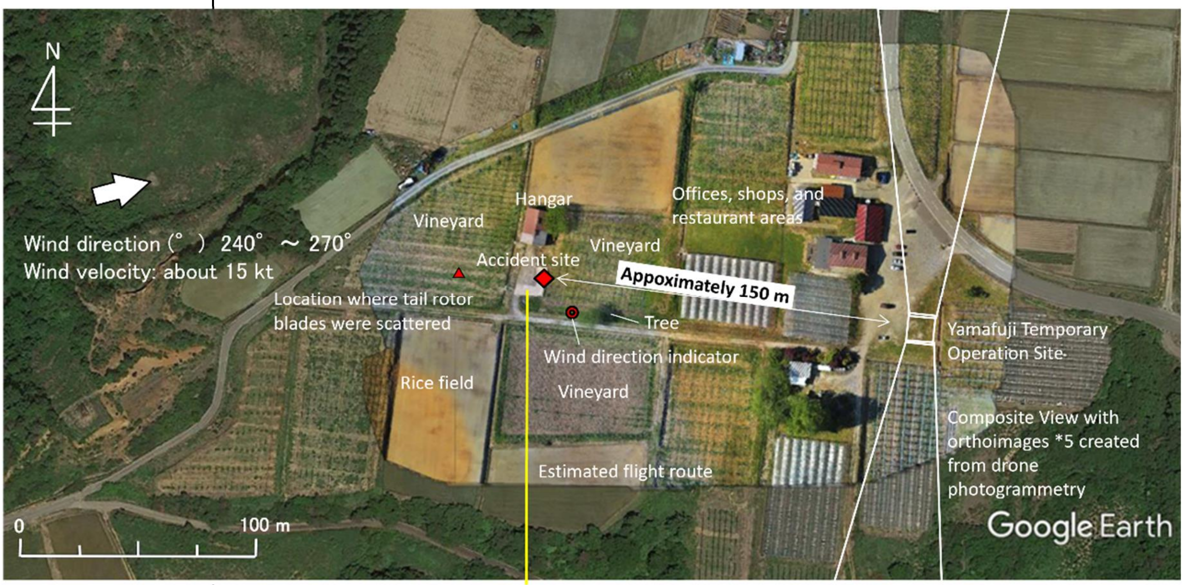


Figure 9: Facilities in the vicinity of the Accident Site and their Locations in relation to the Operation Site

*5 An "Orthoimage" is an image that has been converted from an aerial photograph into an image that is displayed in the correct size and position, without any tilt, as if viewed from directly above, just like a map.

The site where the helicopter rolled over had been used as an operation site with a permit until 2018, but at the time of the accident, the operation site that had been applied for and approved by the Ministry of Land, Infrastructure, Transport and Tourism was approximately 150 m east of the accident site, as shown in Figure 9. (See 2.8 (6) for details of how to apply for an operation site)

(2) Accident Site

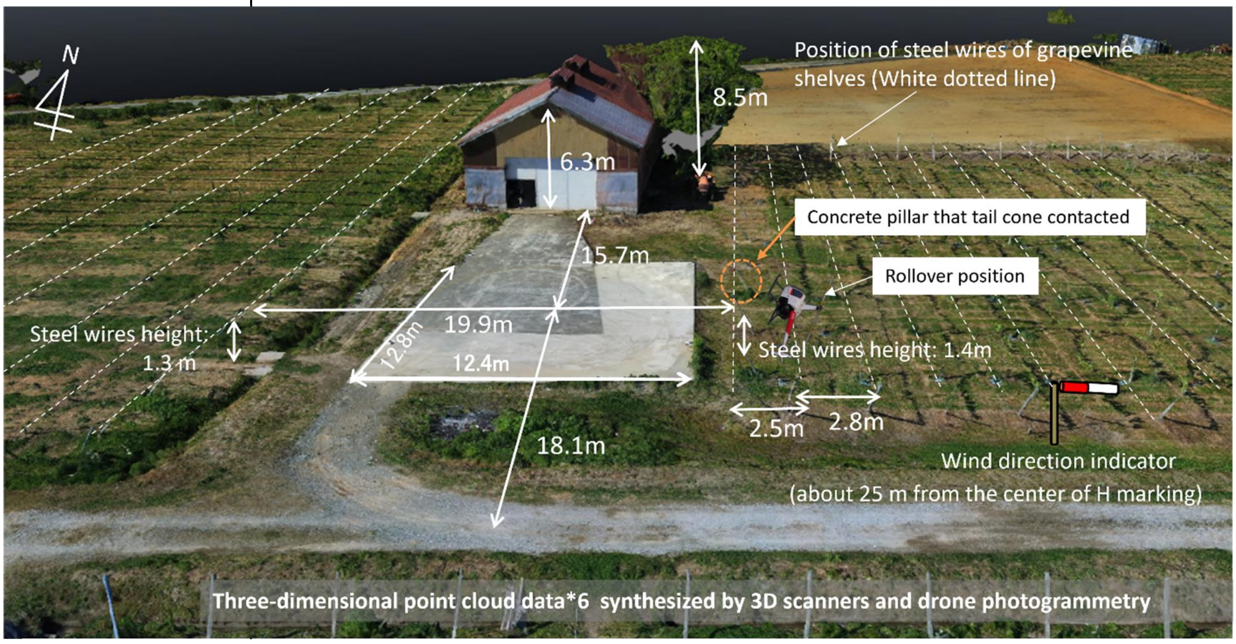


Figure 10: Size of the Old Operation Site and Obstacles in its Vicinity

The Old Operation Site where the accident occurred, as shown in Figure 10, was a concrete paved area with a hangar on its north side and a wind direction indicator approximately 25 m to the south-east. In addition, there were the grapevine shelves approximately 1.3 to 1.4 m high on the east and west side of the Old Operation Site, and the helicopter rolled over, when the steel wires from the eastern grapevine shelves coiled around it.

2.8 Additional Information

(1) Surveillance Camera Video

The helicopter did not have any equipment to record flight track and others, but the video from the surveillance camera installed east of the accident site recorded the helicopter at the time of the rollover and the changes in the movement of the wind direction indicator. In addition, the helicopter's continuous movements at the time of the accident were as shown in Figure 11.

The helicopter approached with a crosswind from the left (a), and as it descended vertically near the Old Operation Site(b), its heading suddenly turned to the left in the direction of the wind (c). Immediately afterwards, the helicopter started to spine 180°/s to the right (d), contacted the steel wires with the main rotor tilted to the left (e), and then continued to spin to the right with the nose up after contacting, causing the helicopter to roll over to the right with the nose

*6 "Three-dimensional point cloud data" refers to a representation in a form that can be processed by calculation of many point data with 3D coordinates that represent the terrain, features, etc., and attribute data that represents the contents of those points. It is created by laser surveying and photogrammetry using drones, etc.

pointed to the north.

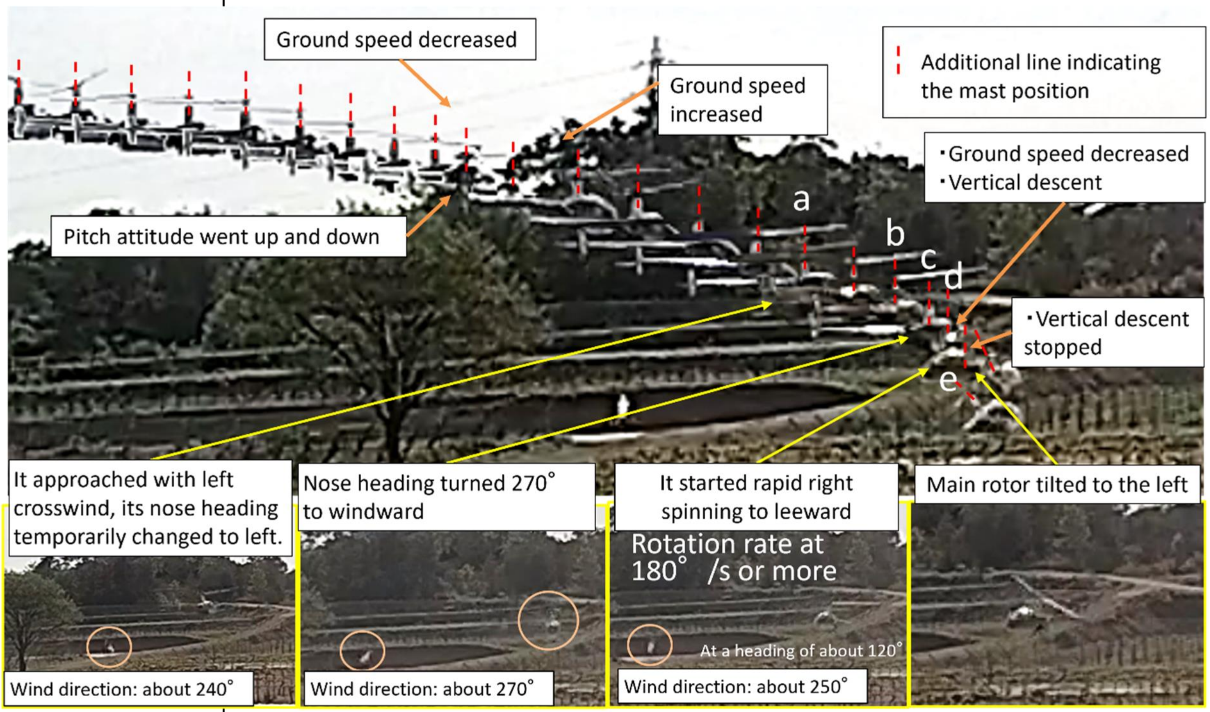


Figure 11: The helicopter's continuous movements during approach (every second)

(2) Robinson R22 Beta Limitations for Surface Winds, Wind Shear and Turbulence

The Robinson R22 Beta Flight Manual describes the limitations for surface winds, wind shear and turbulence as follows:

1 Flight when surface winds exceed 25 kt (46.3 km/h), including gusts, is prohibited.

2 Flight when surface wind gust, spreads exceed 15 kt (27.8 km/h) is prohibited.

(3) Precautions for Unanticipated Yaw*7 Changes on the Robinson R22 Beta

Safety Notice SN-42 attached to the Robinson R22 Beta Flight Manual explains how to react to the unanticipated yaw changes as follows:

UNANTICIPATED YAW

*A pilot's failure to apply proper pedal inputs in response to strong or gusty winds during hover or low-speed flight may result in an unanticipated yaw. Some pilots mistakenly attribute this yaw to loss of tail rotor effectiveness (LTE*8), implying that the tail rotor stalled or was unable to provide adequate thrust. Tail rotor on Robinson helicopters are designated to have more authority than many other helicopters and are unlikely to experience LTE.*

To avoid unanticipated yaw, pilots should be aware of conditions (a left crosswind, for example) that may require large or rapid pedal inputs. Practicing slow, steady rate hovering pedal turns will help maintain

*7 "Yaw" refers to the rotation or rotational movement of an object about a vertical axis.
*8 "LTE" stands for Loss of Tail Rotor Effectiveness, and refers to a sudden, uncontrollable yaw in the opposite direction of the main rotor's rotation due to a loss of tail rotor function or an unexpected yaw.

proficiency in controlling yaw. Hover training with a qualified instructor in varying wind conditions may also be helpful.

(4) Robinson R22 Beta Controls and Limitations on Left-seat Pilot Qualifications

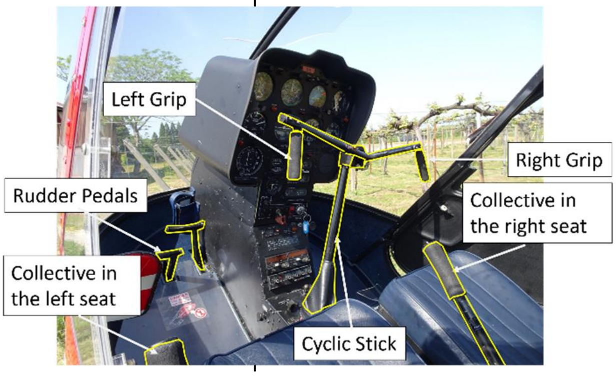


Figure 12: Cockpit of the Helicopter

The Robinson R22 Beta's control system has a single cyclic stick in the center, with cyclic grips connected on both sides at the top as a pivot point. The left and right cyclic grips can be operated by moving in parallel to the center mounted stick. For example, if the right grip is operated at a position slightly above the knees, the left grip is designed to be raised and is therefore at a different height to that normally operated on the right seat. The cyclic stick does not tilt when the grip is moved up or down like a steering wheel. Collectives are provided for each seat and connected by a rod. The left and right pedals are connected by a rod, but the pedal control is not linked to the Cyclic and collective. In addition, it is possible to remove the left seat pilot controls, but the helicopter's left seat pilot controls had been left in place to allow the pilot in the left seat to control the helicopter, as shown in Figure 12.

Since flight training is required to operate the Robinson R22 Beta helicopter in the left seat, the Robinson R22 Beta Flight Manual describes the limitations of left-seat pilot qualifications as follows:

Minimum crew is one pilot in the right seat. A flight instructor may act as pilot in command from the left seat. Solo flight from right seat only.

(5) Weathercock Stability

When a helicopter receives wind from the side attempts to Wind direction indicator and or weathercock, its nose into the relative wind. Especially when a helicopter receives wind from the region of 120° to 240°, as shown in Figure 13*9, unless a resisting pedal input is made, the helicopter starts a slow, uncommanded turn either to the right or left, depending upon the wind direction. If a right yaw rate is allowed to develop and the tail of the helicopter enters this region, the yaw rate can accelerate suddenly. To avoid the onset of LTE in this downwind condition, it is necessary to maintain positive control of the yaw rate and pay full attention to flying the helicopter.

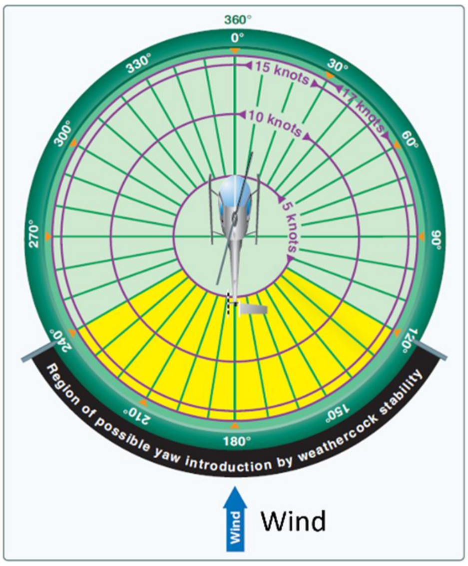


Figure 13: Areas Susceptible to Weathercock Stability

*9 U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION Flight Standards Service "Helicopter Flying Handbook" 2019, pp. 11-20,21

	(6) The Operation Site where the Helicopter is Regularly Based. In principle, the approval period for the operation site permit is three months. The Old Operation Site where the accident occurred had been applied for and continuously approved as a homebase for a Robinson R22 Beta helicopter. Besides, in November 2018, the Old Operation Site was applied for as a homebase with the AS355F2 model aircraft as the maximum aircraft, with an approach route from a direction of 110° and a departure route to a direction of 290°. Subsequently, the Airport Office conducted an on-site inspection of the operation site, the take-off and landing area, and approach surface did not pass the inspection standard, therefore the operator of the Old Operation Site was instructed by the Airport Office not to use it as an operation site. Furthermore, regarding the operator's request to use it only fore Robinson R22 helicopters, the Airport Office suggested that this could be made possible by extending and improving the take-off and landing area, and by lowering the grapevine shelves on the approach and departure sides by about 0.5 m. After that, the take-off and landing area was expanded and improved with concrete, and an application was submitted in April 2019 for a temporary operation site, but it was not accepted due to insufficient content. Subsequently, as shown in Figure 9, the operator applied for and had been granted permission to use the site 150 m east of the Old Operation Site (accident site) as a temporary operation site.

3. ANALYSIS

(1) Influence of Weather

The JTSB concludes as follows.

On the day of the accident, the weather was fine and calm, but in the afternoon, a slightly strong wind blew from north to northwest in the Toyama region. According to aeronautical weather observations for Toyama Airport from 15:00 to 16:00, the wind direction changed from 010° to 300° and the wind velocity was 9 kt. In addition, according to the movement of the wind direction indicator captured in surveillance camera video, the wind direction changed largely between 240° and 270°, and the wind velocity changed between 10 kt and 15 kt during the helicopter's approach, as shown in Figure 8. These changes in wind direction and velocity were close to the Flight Manual wind limitation values for surface wind, wind shear and turbulence, which were most likely to have affected control in low-speed flight.

(2) Flight from Approach to Rollover

The JTSB concludes as follows.

As shown in Figure 11 and Figure 14, the helicopter approached the Old Operation Site from the south side, receiving the wind from the left rear and left side. The helicopter slowed down before approaching the road on the south side of the Old Operation Site, but the pitch attitude went up and down, and the ground speed temporarily increased. This temporary increase in ground speed was more likely caused by the influence of the pilot’s flight control or the wind blowing from the left rear.

Near the landing mark H, the helicopter's heading temporarily changed to the left, the ground speed decreased, and the helicopter's heading suddenly turned to the left during a vertical descent. As for the cause of this, as shown in Figure 15, it is possible that the decrease in airspeed and the change in relative wind direction and speed to the left made the weathercock effect likely to occur, and that the pilot lowered the collective in order to descend, which reduced the thrust of the main rotors, and the input of the right pedal was insufficient to compensate for the decrease in the torque, causing the nose to turn 270° upwind.

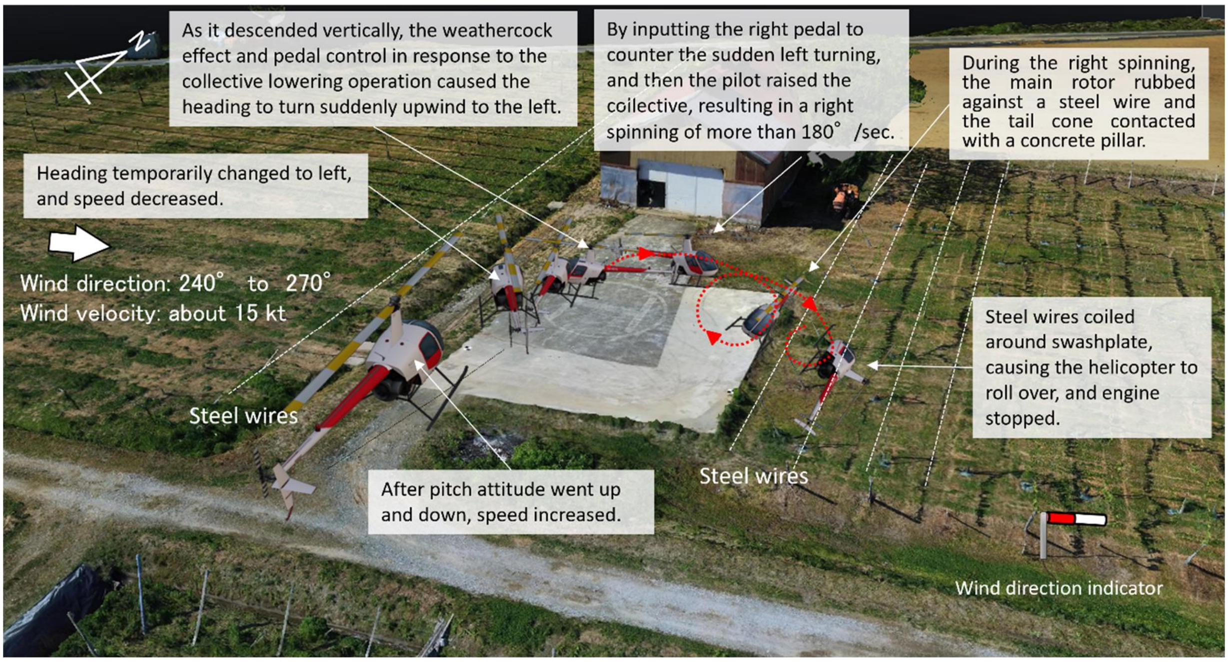


Figure 14: Composite View of the Helicopter's Rollover

After that, the helicopter started to spin around to the right with a heading of changing rate of over 180°/s, the rotor disc tilted to the left while moving eastward, and the main rotor blades rubbed against the steel wires of the grapevine shelves, causing the helicopter to pitch up, the wires coiled around the swash plate, and the helicopter rolled to the right. The pilot stated that the helicopter's heading swung significantly to the left, so he inputted on the right pedal to stop the swing and try to correct it. As shown in Figure 11, the vertical descent stopped immediately after the sudden right spinning began, so it is highly probable that when the nose turned suddenly to the left into the wind, the pilot suddenly applied the right pedal, and then raised the collective to stop the vertical descent, which increased the torque, accelerating the right spinning and causing the helicopter to be LTE.

As to the reason the main rotor tilted to the left and hit the steel wires, because while the helicopter was approaching in receiving the wind blowing from the left, the pilot probably made a cyclic input to the left to maintain the approach path. It is probable that when the helicopter started a rapid spinning to the right, as the cyclic was held to the left, the main rotor left began to tilt to the left, and it spun while the center of rotation shifted outwards. Therefore, the cyclic was possibly held to the left until the main rotor rubbed the steel wires. In addition, the pilot stated that the pilot was trying to recover, and the passenger stated that to stop the helicopter moving forward, the passenger operated the cyclic grip which was at up position. During the rapid right spinning of more than 180 °/s, the cyclic operation to tilt the main rotor rearwards would have probably worked with a delay, therefore, the cyclic operation by the passenger had possibly affected the nose up of the helicopter that occurred after the main rotor blades rubbed the steel wires. It is probable that the rapid right spinning to be the LTE was mainly due to the pilot's pedal inputs and the collective operation, and the influence of the flight control performed in the left seat was limited, however, in the past helicopter rollover accidents, there are many cases where the flight control performed in the left seat caused excessive flight control inputs, resulting in the rollover accident, therefore, it is probable that a pilot without a flight instructor certificate should avoid controlling from the left seat.

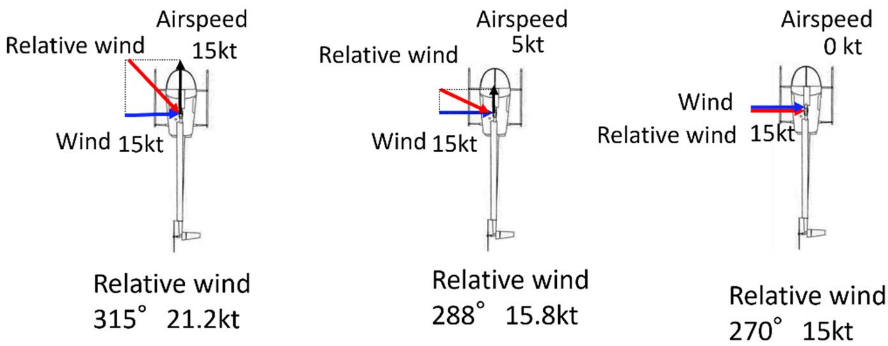


Figure 15: Examples of Changes in Relative Wind Direction and Velocity due to Decrease in Airspeed

(3) How to React to Rapid Changes in Wind Direction and Velocity and Unanticipated Yaw

The JTSB concludes as follows:

When the helicopter flew over the west side of the Old Operation Site, the wind was blowing from 300° at about 10 kt but changed to a wind of 10 to 15 kt blowing from 240 to 270° during the approach from the south side, the helicopter was probably approaching with a slight tailwind from the left side of the helicopter. It is more likely that when approaching with a left tailwind, the slower the airspeed, the more the relative wind direction shifts increasing the likelihood unanticipated yaw. Additionally, it is more likely that when a decrease in airspeed is combined with collective control inputs, especially in conditions with significant wind changes, pedal operation will become more complex.

To avoid unanticipated yaw, the safety notice states, "Practicing slow, steady rate hovering pedal turns will help maintain proficiency in controlling yaw." To avoid the circumstances under which an unanticipated yaw phenomenon may occur during take-off and landing, when the wind direction and velocity vary greatly, it is important to keep the helicopter's heading as straight as possible into the wind and to avoid radical pedal inputs and collective control during low-speed flight and hovering.

(4) Requirements for the Take-off and Landing Area and Influence of Obstacles

The JTSB concludes as follows:

The Old Operation Site from which the helicopter was to land was different site from the one for which the operation site permit had been granted. Therefore, it confirmed about the requirements for use for take-off and landing of rotorcraft of the permit requirements prescribed in the proviso of Article 79 of the Civil Aeronautics Act (see Appendix), as well as its influence on the approach path from the south that the helicopter had taken.

As a result, it was confirmed that the following did not meet the requirements. (See Figure 16)

a. Within the transition surface, which is twice the width of the take-off and landing area, three rows of grapevine shelves on the east side were projected from and above the surface with a slope of one-tenth (the first row was projected from the surface by 80 cm).

b. Within the area of the departure route and approach route, two rows of grapevine shelves on the western side were projected from and above the surface with a slope of one-eighth.

When the helicopter started a rapid right spinning and moved to the right, the main rotor tilted to the left and rubbed against the steel wires protruding 80 cm above the transition surface of the first row of the grapevine shelves on the east side. It is possible that if the transition and approach surfaces had been secured in accordance with the standards for the operation site, and the helicopter had chosen the approach path from a 110° direction, as applied for, and approved in 2018, the helicopter would not have approached with a tailwind from the left side and the rapid change in nose heading could have been avoided.

In order to avoid contact with obstacles, even if the helicopter's attitude is unstable due to an unforeseen situation, it is necessary to apply for and improve the operation site in accordance with the requirements for limited surface, take-off and landing area and others, and to operate it by obtaining a permit.

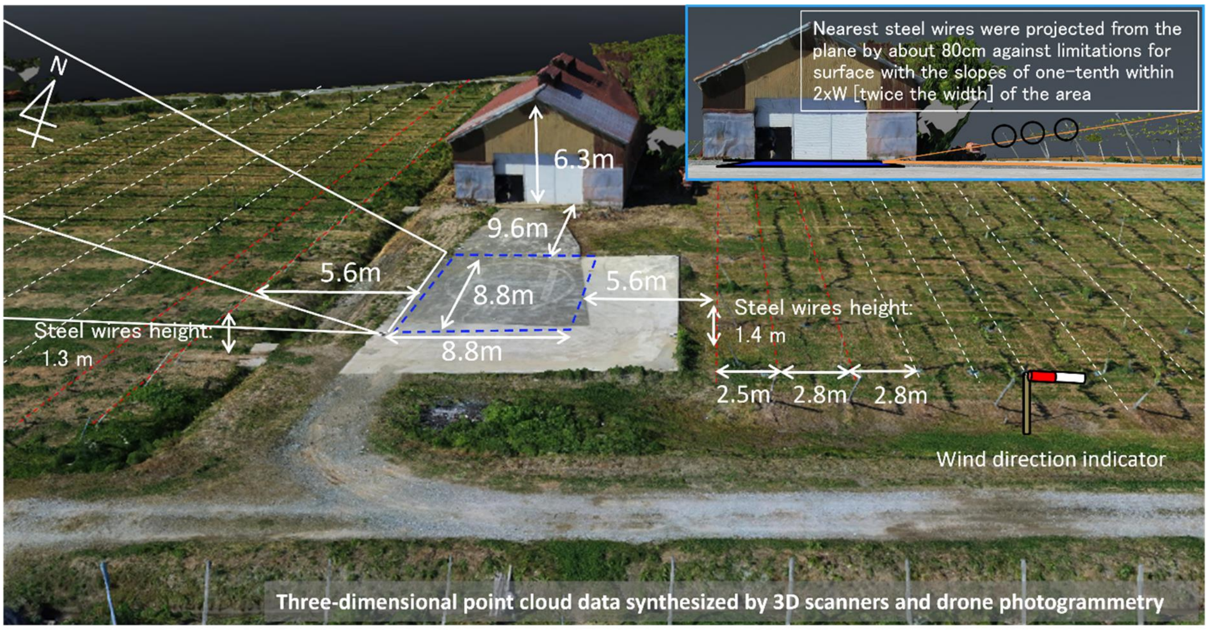


Figure 16: Confirmation of the Requirement for the Take-off and Landing Area and Others

4. PROBABLE CAUSES

The JTSB concludes that the probable cause of this accident was most likely that as the helicopter was transitioning from a low-speed flight to hover, the wind direction and wind velocity changed and a sudden unanticipated yaw occurred, resulting from radical pedal inputted and collective controlled which caused the radical spinning around to the right, resulting in being the LTE, and the main and tail rotors contacting obstacles in the vicinity, resulting in the helicopter rolling over and damage to the helicopter.

5. SAFETY ACTIONS

5.1 Safety Actions Required	(1) How to React to the Unanticipated Yaw To avoid the circumstances under which an unanticipated yaw phenomenon may occur during take-off and landing, when the wind direction and velocity vary greatly, it is important to keep the helicopter's heading as straight as possible into the wind and to avoid radical pedal inputs and collective control during low-speed flight and hovering. (2) Secure Application for Operation Site Permit In order to avoid contact with obstacles, even if the helicopter's attitude is

	unstable due to an unforeseen situation, it is necessary to apply for and improve the operation site in accordance with the requirements for limited surface, take-off and landing area and others, and to operate it by obtaining a permission.

Appendix: Safety Services Regulation (Excerpt)

The following provisions apply to the granting of permission under the proviso to Article 79 of the Act for aircraft to take off or land at a place other than aerodromes.

(b) In case of use for take-off and landing of rotorcraft
(i) General

Take-off and Landing Area	*Location and Direction*	*The location and direction shall be selected to establish a take-ff and landing path in which the helicopter can make a forced landing safely without endangering people or objects on the land or water in case of power unit failures.*
	Length and Width	*As for the length, it shall be longer than the length of the projected plane of rotorcraft to be used (hereinafter referred to as "total length"), and for the width, it shall be longer than the width of the projected plane of rotorcraft to be used (hereinafter referred to as "total width").*
	Surface	*It shall be sufficiently flat with the maximum longitudinal slope and Maximum transverse slope of 5% and possess sufficient strength to withstand the operation of rotorcraft to be used.*
Approach Area and Approach Surface	*In principle, the approach area and approach surface shall be specified as shown in Attached Figure 3. However, if the approach and departure paths cannot be established in the same direction, they may be established as shown in Attached Figure 4. The slope of approach surface shall be not more than one-eighth in the take-off direction, not more than one-fourth in the landing direction, and there shall be no object higher than the approach surface.*	
Transition Surface	*In principle, the transition surface shall be specified as the surface with a slope of not more than one over one, as shown in Attached Figure 3. There shall be no object higher than the transition surface, and there shall be no object projecting from the surface with a slope of one-half within 10 m from each long side of the take-off and landing area. However, regarding the transitional surface on the one long side of take-off and landing area (hereinafter referred to as "long side A"), if there is no object projected from the horizontal plane including the highest point of the take-off and landing area within the distance equal to three-fourths diameter length of the rotary wings of helicopters for which the heliport located outside the longer side A is expected to be used, and another long side (hereinafter referred to as "long side B") within the distance longer twice the length of the short side of the take-off and landing area of long side B of outside the take-off and landing area and no object is projected from the plane with the slopes of one-tenth above the outside of the take-off and landing area, it may be specified as the surface with a slope of one over one or more, as shown in Attached Figure 5. In this case, the slope of the transitional surfaces on the long side B shall be not more than one over one, there shall be no object higher than the transition surface.*	

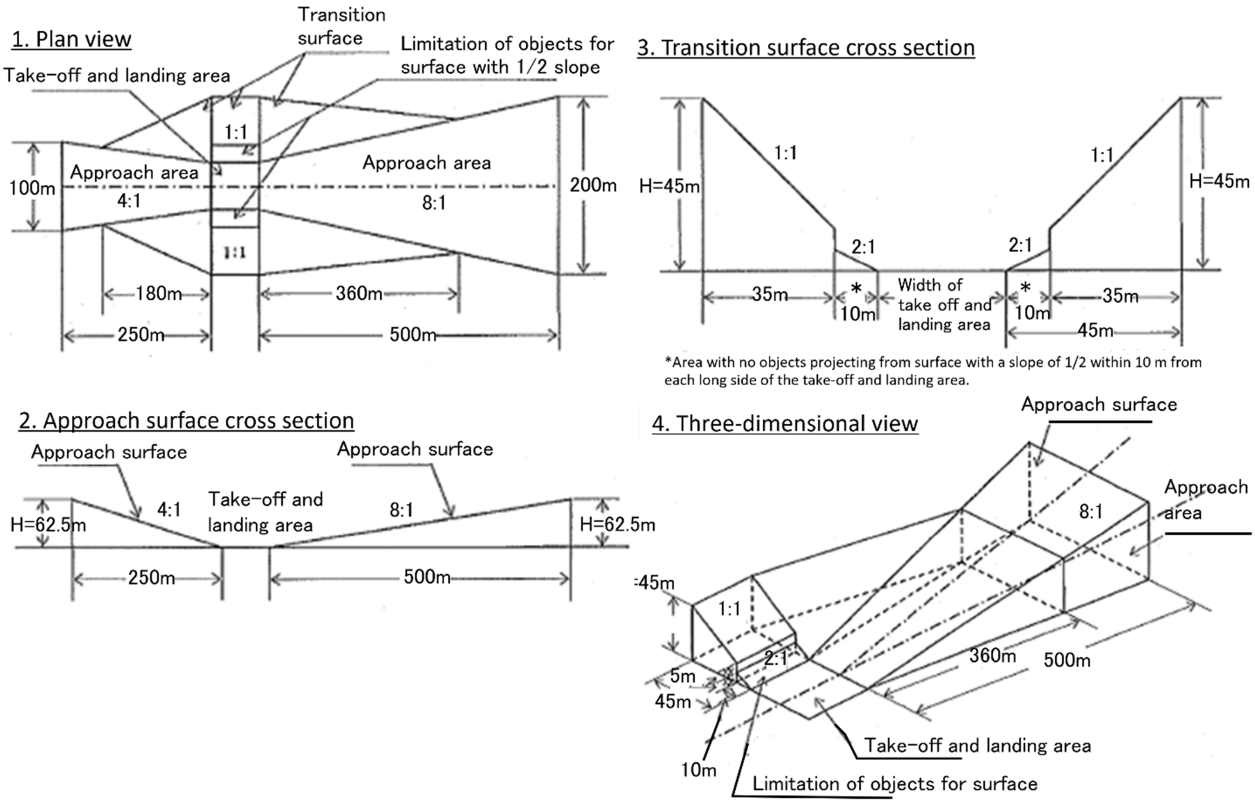
b. Safety Measures and Other Requirements

The following safety measures shall be taken. It is advisable to obtain the consent of residents as there is a risk of damage from noise, dust, and others.

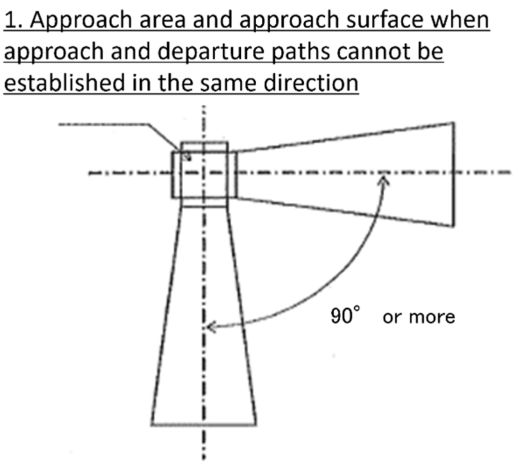
(a) Installation of Signs and Markings

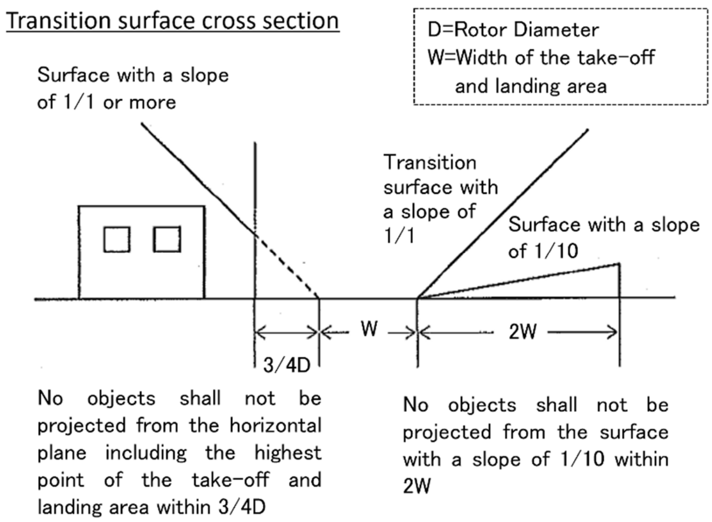
(ii) In case of use for take-off and landing of rotorcraft

At the take-off and landing area, signs and markings indicating the boundary shall be installed in such a way that they can be visually confirmed by rotorcraft intending to take off from or landing there, and the wind direction indicator shall be installed as close as possible to it, (provided, however, that this does not apply if it is impossible or significantly difficult to install them).



Appended Figure 3: Diagram Sketch of Approach Area and Approach Surface and Transition Surface for Rotorcraft





Appended Figure 4: Diagram Sketch of Approach Area and Approach Surface and Transition Surface for Rotorcraft
(General (Ⅳ), 9-(3)-a-(b)- (i) proviso - Variant pattern for aopproach area and approach surface)

Appended Figure 5: Diagram Sketch of Transition Surface for Rotorcraft
((Ⅳ)-9-(3)-a-(b)- (i) proviso -Transition surface)