

AA2017-2

**AIRCRAFT ACCIDENT
INVESTIGATION REPORT**

**PRIVATELY OWNED
J A 3 7 8 8**

March 30, 2017



The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board and with Annex 13 to the Convention on International Civil Aviation is to 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.

Kazuhiro Nakahashi

Chairman

Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

AIRCRAFT ACCIDENT INVESTIGATION REPORT

CRASH DURING GO-AROUND A PRIVATELY OWNED MOONEY M20C, JA3788 YAO AIRPORT, OSAKA PREFECTURE, JAPAN AT ABOUT 16:18 JST, MARCH 26, 2016

March 10, 2017

Adopted by Japan Transport Safety Board

Chairman	Kazuhiro Nakahashi
Member	Toru Miyashita
Member	Toshiyuki Ishikawa
Member	Yuichi Marui
Member	Keiji Tanaka
Member	Miwa Nakanishi

SYNOPSIS

<Summary of the Accident>

A privately owned Mooney M20C, registered JA3788, bounced while landing on Runway 27 of Yao Airport and attempted go-around, but stalled during climbing and went into spin, and then crashed into the south side shoulder of the runway at about 16:18 Japan Standard Time on Saturday, March 26, 2016.

A captain and three passengers were on board and all of them were fatally injured.

The aircraft was destroyed and a fire broke out.

<Probable Causes>

In this accident, the aircraft bounced while landing and attempted a go-around, and it made an abnormal nose-up continued and decelerated, and then the stall could not be avoid in a situation where it imminent; consequently, it is highly probable that it stalled and went into spin, and finally it had crashed.

Regarding the reason why the stall could not be avoid in the imminent situation, it is somewhat likely that the captain or passenger A who maneuvered the aircraft could not suppress the excessive nose-up movement because it was exceeding the maneuverable range and others. All members of the aircraft on board were died; accordingly, the investigation was unable to determine the causes.

Besides, the aircraft had overweight and aft CG location for the aft limit corresponding to the maximum weight. It is somewhat likely that these condition affected the controllability and the stability, and contributed to the bounce on touchdown, the abnormal nose-up posture during a go-around, the decreased stability at low speed flight and the occurrence of stall and spin.

Unit Conversion Table

1 ft	: 0.3048 m
1 in	: 25.40 mm
1 kt	: 1.852 km/h
1 lb	: 0.4536 kg
1 nm	: 1,852 m

1. PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident

A privately owned Mooney M20C, registered JA3788, bounced while landing on Runway 27 of Yao Airport and attempted go-around, but stalled during climbing and went into spin, and then crashed into the south side shoulder of the runway at about 16:18 Japan Standard Time (JST: UTC +9 hours, all times are indicated in JST on a 24-hour clock) on Saturday, March 26, 2016.

A captain and three passengers were on board and all of them were fatally injured.

The aircraft was destroyed and a fire broke out.

1.2 Outline of the Accident Investigation

1.2.1 Investigation Organization

On March 26, 2016, the Japan Transport Safety Board designated an investigator-in-charge and an investigator to investigate 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

March 27-29, 2016	Interviews, airframe examination and on-site investigation
April 5 and 6, 2016	Interviews, airframe examination and documents investigation

1.2.4 Comments from the Parties Relevant to the Cause of the Accident

Comments were not invited from parties relevant to the cause of the accident, because all members on board were fatally injured in this accident.

1.2.5 Comments from the Relevant State

Comments on the draft Final Report were invited from the relevant state.

2. FACTUAL INFORMATION

2.1 History of the Flight

A privately owned Mooney M20C, registered JA3788, with the captain sat in the left pilot seat to maneuver, took off Kohnan Airport at 11:00 JST on March 26, 2016, for a familiarization flight, landed at Yao Airport at 12:00 and had refueled. The aircraft with the captain sat in the right pilot seat, the passenger C in the left pilot seat and the passenger B and passenger A sat in the rear seats, took off Yao Airport at 14:31 and landed at Kobe Airport at 14:43. The aircraft with the captain in the right pilot seat, the passenger A in the left pilot seat and the passenger B and passenger C in the rear seats, took off Kobe Airport at 16:03 for Yao Airport.

The flight plan of the aircraft was outlined below:

Flight rules: Visual flight rules (VFR)

Departure aerodrome: Kobe Airport

Estimated off-block time: 15:55

Cruising speed: 100 kt

Destination aerodrome: Yao Airport

Total estimated elapsed time: 0 hour 30 minutes

Fuel load expressed in endurance: 4 hours 0 minute

Persons on board: Four

The history of the flight up to the time of the accident, based on the radar tracking records and the air traffic control communication records, and the statements of a local controller (hereinafter referred to as “Yao Tower”), a ground controller (hereinafter referred to as “Yao Ground”) of Yao Airport Control Facility, eyewitnesses and an acquaintance of the captain (hereinafter referred to as “acquaintance A”) was summarized below.

2.1.1 Information Based on Radar Tracking Records

The estimated flight route of the aircraft between Yao Airport and Kobe Airport based on the radar tracking records of Kansai Terminal Radar Control Facility was shown in Figure 1.

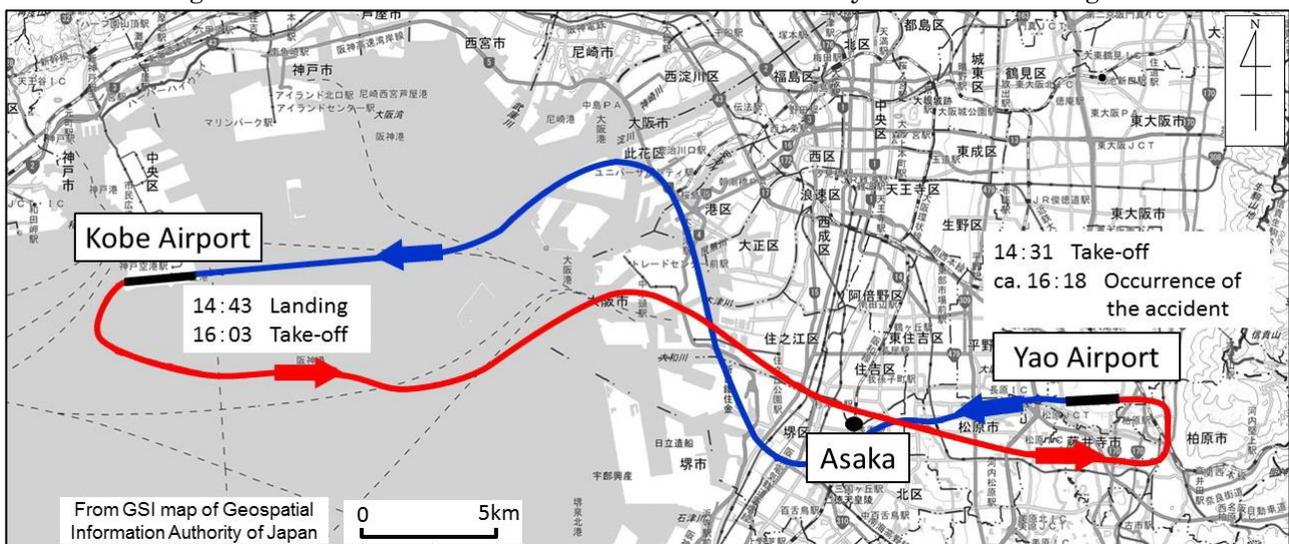


Figure 1 - estimated flight route (between Yao Airport and Kobe Airport)

2.1.2 Information Based on Air Traffic Control Communication Records

(1) From Kohnan Airport to Yao Airport

Based on the air traffic control communication records between the aircraft and Yao Tower, and its aircraft and Yao Ground at the time of the landing, it landed at Yao Airport via a left down-wind leg. After the landing, the aircraft did not find the route to the designated spot, and it was receiving a guidance in Japanese.

(2) From Yao Airport to Kobe Airport

The voice of the person who communicated during the flight from the take-off Yao Airport to Kobe Airport was different one from the voice of the communicator as described in (1).

In addition, he mistook twice the call sign of the aircraft itself in the communication, but corrected immediately.

(3) From Kobe Airport to Yao Airport

The communicator of the aircraft during the flight from Kobe Airport to Yao Airport had different voices from those as described in (1) and (2). Besides, it was not clear whether only the last communicator was different one or not.

The communication between the aircraft and air traffic controller of Kobe Airport (hereinafter referred to as “Kobe Tower”) and Yao Tower respectively were outlined as below:

- 16:01:20 The aircraft reported to be ready for departure. Kobe Tower approved to turn left and issued the take-off clearance to the aircraft, and the aircraft read back them.
- 16:07:30 The aircraft reported Kobe Tower leaving the air traffic control zone at 5 nm southeast. Kobe Tower approved the change of frequency.
- 16:11:54 The aircraft requested a landing information from Yao Tower over Asaka. Yao Tower instructed the aircraft to report at the left down-wind leg with landing information.
- 16:14:30 The aircraft reported that it entered to the left down-wind leg. Yao Tower issued landing clearance with the information of wind direction 270° and the wind velocity 6 kt.
- 16:16:41 Yao Tower broadcast that the wind direction was 280° and the wind velocity 5 kt.
- 16:18:09 The aircraft transmitted “Going around, Juliet Alfa Three Seven Eight Eight” within about 1.8 seconds by blind transmission.

2.1.3 Information based on Interviews

(1) Controllers (mainly based on the statement of Yao Tower and supplemented with the statement of Yao Ground)

The aircraft entered the air traffic control zone from Asaka in 5 nm west of Yao Airport and approached Runway 27 from the left down-wind leg. As a controller saw that the aircraft touched down and was slow speed; therefore, he was looking it and thought that it would stop. However, the aircraft lowered its body slightly after its wheels floated, then it took the attitude to refloat and it reported a go-around in the front of the tower. As he heard the sound of engine output going up, the aircraft was flying over the runway like a level-flight for a while and gradually started to nose up. However, as the nose up did not stop, he could see the upper surface of the fuselage, and he thought that the aircraft would stall, it quickly

crashed straight down.

Yao Ground reported the occurrence of the accident to the fire department and an air traffic services flight information officer with a crash phone*¹ almost at the same time as the aircraft crashed. When reporting, Yao Ground saw smoke rising from the aircraft.

(2) Eyewitness A (a staff of operator A at Yao Airport)

Eyewitness A, when he was doing after flight check and refueling for an aircraft parking in South Apron, saw the crash of the aircraft. He thought that the aircraft were taking off as he was watching, it had a large nose-up posture and the speed was so slow, and then it further nosed up and its speed was abnormally slow. Later on, the posture returned to level but the aircraft began to descend and stagger, and then as turning to left quickly, went into spin and crashed. He could hear the sound of engine at the time of the take-off continued till the crash onto the ground. The aircraft showed its upper surface to the eyewitness A when falling onto the ground, two impact sounds were heard and the flame risen up. The maximum altitude of the aircraft was about 100 ft.

(3) Eyewitness B (a staff of operator B at Yao Airport)

Eyewitness B, when heading by towing car toward an aircraft to be stored, saw the aircraft flying about 10 m east of the Taxiway A3 from abeam at a front of a hanger. As the aircraft was in a large nose-up posture and was flying obviously slow, he said to a staff with him, if it stays like that, it would be dangerous. Later on, its attitude returned to level, and moving forward as sinking slowly, the aircraft went into spin as if it stalled from the left wing and dived almost upside down. The sounds of engine were sound at the time of high power and not the unusual one. However, if it were a departure aircraft, the sounds should pass through, but he felt odd because it sounded from the same direction. Its maximum altitude was between 30 m and 40 m and the angle of attack was approximately 30°.

Eyewitness B, after witnessing the accident, he run to the site with a fire-extinguisher in his hand. Meanwhile, the fire was seen between the base of right wing and the cabin, then it gradually become larger and emitted black smoke. The fire engine came soon and started fire-fighting activities.

(4) Eyewitness C (a staff of operator C at Yao Airport and the instructor for three passengers of the aircraft)

Eyewitness C saw the aircraft when he was preparing an aircraft parked in South Apron for a flight. The aircraft was in the climbing posture, but the attitude was abnormally large nose-up posture and was in a state just before the stall. At the next second, it rolled to left and fell from the nose.

(5) Acquaintance A (a commissioned pilot of the owner company D of a private aircraft)

Acquaintance A had heard from the captain beforehand about the flight of the aircraft to stop by Yao Airport and the three license-holders (meaning the three passengers) who were acquainted with him were going to visit the acquaintance A's affiliation office at first. He heard that these three passengers were the group of people trying to get instrument flight licenses. On the day of the accident, he was waiting for the arrival of the aircraft with the three passengers at the office. And at that time, he showed the instrument approach charts of Yao Airport and other two airports to them and all of them told him that they had never

*¹ "crash phone" is an emergency phone to broadcast to all relevant parties from control tower when an emergency situation occurred.

seen those; accordingly, he felt that they have little experience even though they had private pilot licenses. Shortly, the aircraft arrived and parked in South Apron with one other aircraft from Kohnan Airport. Acquaintance A explained about aircrafts owned by each operator which hangers faced to South Apron to seven to eight people including the captain, three passengers and people who arrived from Kohnan Airport. After the tour of the place, acquaintance A urged them to fly the aircraft, and the captain also urged to do it. Acquaintance A meant a flight around Yao Airport, but three passengers said, that they knew Kobe well. Though acquaintance A thought to be on board and sit in the right pilot seat, the captain said that he had flown Mooney for 80 hours since then, and he would go. Acquaintance A did not object to this, considering the captain having flights on Mooney for 80 hours and experiences of flying to Kumamoto and Naha. The Acquaintance A decided to help the captain to submit the flight plan of the round trip to Kobe Airport with due consideration for him to be busy to make contacts to various related parties. Acquaintance A left the apron and went to the Yao Airport Office to submit the flight plans himself. Since then, he did not see the aircraft until the accident occurred.

The accident occurred at the south side shoulder of Runway A (09/27) in Yao Airport, Osaka Prefecture, Japan (34° 35' 44" N 135° 35' 35" E) at around 16:18 on March 26, 2016.

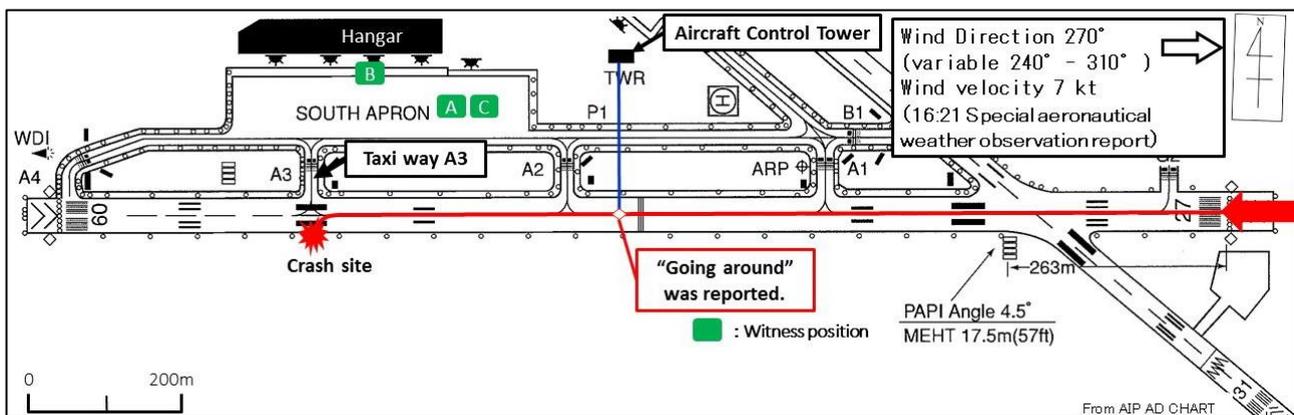


Figure 2 - estimated flight route (detailed)

2.2 Injuries to Persons

All passengers (four persons) on board were killed.

2.3 Damage to the Aircraft

2.3.1 Extent of Damage

Destroyed

2.3.2 Damage to the Aircraft Components

- Fuselage: Broken, partial burned
- Wings: Collapsed
- Engine: Detached from the fuselage
- Propeller: Detached from the engine, the shaft fractured, bent all of two blades
- Landing gear: Damaged the nose landing gear and the down lock mechanism of the left landing gear



Photo 1 - the aircraft

2.4 Personnel Information

(1) Captain	Male, Age 45	
Private pilot certificate (Airplane)		
Rating for single engine (Land)		November 4, 2014
Class 2 aviation medical certificate		
Validity		February 16, 2017
Specific pilot competence certificate		
Expiration date of piloting capable period		November 4, 2016
Total flight time		138 hours 47 minutes
Flight time in the last 30 days		4 hours 8 minutes
Total flight time on the type of aircraft (the aircraft)		41 hours 50 minutes
(His total flight time since he started to fly the aircraft on February 15, 2015 was 42 hours 57 minutes. Number of his landing with the aircraft was 53 times.)		
Flight time in the last 30 days		4 hours 8 minutes
(2) Passenger A	Male, Age 40	
Private pilot certificate (Airplane)		
Rating for single engine (Land)		May 22, 2003
Multi-engine (Land)		October 24, 2013
Class 2 Aviation medical certificate		
Validity		January 1, 2018
Specific pilot competence certificate		
Expiration date of piloting capable period		October 24, 2015
Total flight time		279 hours 48 minutes
Flight time in the last 30 days		1 hours 28 minutes
Total flight time on the type of aircraft		0 hour 0 minute
(He flew the retractable landing gear type aircraft on August 3, 2014 as the last time.)		

2.5 Aircraft Information

2.5.1 Aircraft

Type	Mooney M20C
Serial number	20-1234
Date of manufacture	July 28, 1977
Certificate of airworthiness	Dai -2015-073
Validity	May 14, 2016
Category of airworthiness	Airplane, Normal, N
Total flight time	2,333 hours 10 minutes
Flight time since last periodical check (100-hr check on March 10, 2015)	30 hours 38 minutes
(See Appendix "Three Angle View of Mooney M20C".)	

2.5.2 Weight and Balance

When the accident occurred, the weight and center of gravity (CG) location of the aircraft were estimated as shown in Figure 3: the weight was 2,691 lb which exceeded the maximum weight (2,575 lb) by 116 lb. The CG location was 49.53 in aft of the reference point (the centerline of the nose landing gear support bolt) and 0.53 in aft for the aft limit (49.00 in) corresponding to the maximum weight.

Besides, when the aircraft took off at Yao Airport, the weight was 2,726 lb exceeded the maximum weight by 151 lb. When the aircraft took off at Kobe Airport, the weight was 2,708 lb exceeded the maximum weight by 133 lb and the CG location was 0.52 in aft for the aft limit corresponding to the maximum weight. (See 2.10.1)

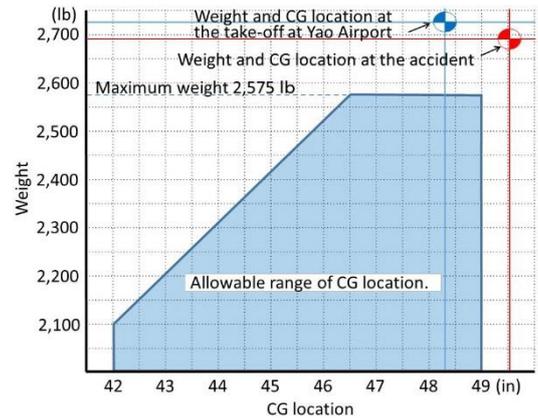


Figure 3 - weight and CG location

2.6 Meteorological Information

Aviation special weather report of Yao Airport, around the time of the accident were as follows:

- 16:21 Wind direction 270°; Wind direction variable from 240° to 310°; Wind velocity 7 kt
- Prevailing Visibility 40 km
- Cloud: Amount 1/8, Type Cumulus, Cloud base 3,500 ft
- Amount 5/8, Type unknown, Cloud base unknown
- Temperature 12°C; Dew point -4°C; Altimeter setting (QNH) 30.07 inHg

2.7 Accident Site and Wreckage Information

2.7.1 Accident Site

The accident site was around the south side runway shoulder at the intersection of Runway A and Taxiway A3 of Yao Airport. The aircraft was facing its nose to north, and its front tip was at about one meter south from the border of paved surface. The nose landing gear was hidden behind the engine which was detached from the fuselage, the bottom of the nose touched the grassland, the down lock mechanism of the left landing gear was damaged and bent, the right landing gear was deployed and the aircraft was tilted to left. A deformed engine cowl was detached and was at the front of the engine.

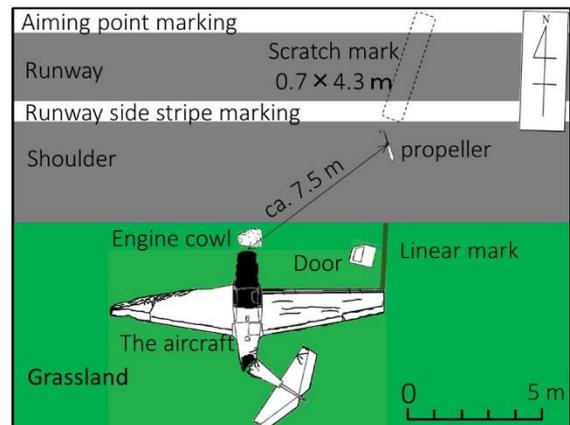


Figure 4 - accident site

The detached propeller from the fuselage was at about 7.5 m northeast from the nose to with spinner facing upward. The paved surface under the propeller have a crescent shaped dent which was approximately 40 cm in length, 10 cm in width and 2.6 cm in maximum depth. Within a circular area of one meter in diameter around the dent as its center, blue and white scratch marks and small dents were resulted. From the point, the area of approximately 2 m north and 4.3 m north-northeast and 0.7 m in width had white scratch marks and small debris of the red navigation light. The grass were crushed like marks in line from the position of the propeller to the right wing tip, and the area around had debris of the green navigation light scattered. The pilot seat door was detached and

found about 4 m east of the engine.

Push-pull rods and torque tubes were used for the steering device of the control system. There were no anomaly in their connections and operation statuses of elevator control rod. The operation statuses of other control systems could not be confirmed due to the bending and curving along with the airframe. Flaps were at the full extension (33°). The elevator trim positioned in middle of a total excursion. The control switch of the landing gears was at gear down position. The positions of three control knobs of throttle, mixture and propeller pitch of the aircraft at the time of crash were not able to be confirmed due to the total destruction. The ignition plugs of engine had traces of normal combustion. The ceiling of cockpit was cut off for the rescue operation.

2.7.2 Details of Damage

(1) Fuselage;

As for the fuselage, the external plate of about 70 cm to 170 cm in length to aft from the wing was broken, leaving the right side, the rear part was bent to the right, and the right side of the external plate was folded like bellows. The floor surface of the pilot seats was bent about 60 degree upward from the foot. The right side of the cabin and the fore part of the right wing base were damaged by the fire, especially the right pilot seat was severely burnt (See Photo 2).



Photo 2 - bent of the floor surface of the pilot seat

(2) Wings;

As for the left wing, the external plate from 180 cm outside of the base to the wing tip was ripped open to upward by impact from downside and folded like bellows, and the red navigation light was broken with the external plate of the wing tip. As for the right wing, the leading edge from the base to the wing tip was collapsed like bellows due to the impact from front, and the green navigation light was broken with the external plate of the wing tip. The soil got into the joint of the external plates into base from the wing tip direction (See Photos 3 and 4).



Photo 3 - left wing



Photo 4 - right wing

(3) Engine;

The engine was detached from the fuselage due to the fracture of the lower frame and

connected only by the cables; however, there was almost no fire damage.

(4) Propeller;

As for the propeller, the shaft was fractured and two blades were irregularly bent backward. Placing on the ground at the flattened surface of the spinner which was crashed onto ground and deformed; moreover, the angle between the shaft and the ground was approximately 60°. The alternator attached at front in lower-right of the engine had damaged the ring-gear. Based on the positional relation between the position of the damage and the alternator, the attitude of the aircraft at the time of the crash onto ground was approximately -120° in pitch angle and 30° in roll angle

(See Photo 5).



Photo 5 - propeller

(5) Landing Gear;

The nose landing gear was damaged at the mounting part with the frame. The down lock mechanism of the left landing gear was damaged.

2.8 Medical Information

According to the Osaka Prefectural Police Department, the cause of death of the persons on board were as follows: the captain who sat in the right pilot seat died with a pneumocranium; passenger A in the left pilot seat died with brain crush injury; passenger B in the left rear seat died with central breathing paralysis; passenger C in the right rear seat died with a blood loss. The blood samples of the captain and passenger A tested negative for alcohol and addictive drug.

2.9 Fire, Fire-fighting and Rescue Information

(1) Statement of the staff of Air Safety Foundation

As the staff picked up a crash-phone and looked at outside, he saw the accident aircraft. Immediately, two of them started to drive the fire engine to the site. Within about 30 seconds, they arrived at the site. As the wind was blowing from west, he sprayed water using water gun on board from the slightly westerly direction for 30 seconds. The fire stopped its momentum as switching to a hand-hose for a few minutes; consequently, the fire was completely went off.

(2) Statement of the officer of the Yao Fire Department

- 16:33 Requested an air ambulance
- 16:37 Fire-fighters of Yao Fire Department arrived on the site.
- 16:48 The air ambulance arrived at the site.
- 16:55 All persons on board were confirmed dead by a doctor.

(3) Conditions of the seatbelts

All seatbelts were wearing.

2.10 Tests and Researches for Fact-Finding

2.10.1 Estimation of Weight and Balance

When the accident occurred, the weight of the aircraft was estimated to have been 2,691 lb and its CG location was estimated to have been 49.53 in aft of the reference point. The condition were as follows.

• Empty weight		1,622 lb
• Weights of people on board	The captain	134 lb
	Passenger A	152 lb
	Passenger B	158 lb
	Passenger C	251 lb
• Fuel	at the time of take-off at Yao Airport	312 lb
	at the time of take-off at Kobe Airport	294 lb
	at the time of the accident	277 lb
• Baggage	Baggage Compartment	70 lb
	Rear seat	27 lb

Table 1 - estimation of weight and CG location

	Weight (lb)	Arm (in)	Moment (in·lb)
Empty weight	1,622	44.22	71,725
Fuel ; at the time of take-off at Yao Airport	312	48.43	15,110
; at the time of take-off at Kobe Airport	294	48.43	14,238
; at the time of the accident	277	48.43	13,415
Front seat ; at the time of take-off at Yao Airport	385	37.75	14,534
; at the time of take-off at Kobe Airport	286	37.75	10,797
; at the time of the accident	286	37.75	10,797
Rear seat ; at the time of take-off at Yao Airport	337	70.70	23,826
; at the time of take-off at Kobe Airport	436	70.70	30,825
; at the time of the accident	436	70.70	30,825
Baggage compartment	70	93.00	6,510
Total ; at the time of take-off at Yao Airport	2,726	48.31	131,705
; at the time of take-off at Kobe Airport	2,708	49.52	134,095
; at the time of the accident	2,691	49.53	133,272

2.10.2 Estimation of Approach Angle, Speed and Altitude of the Aircraft based on the Images of Camera

(1) Estimation of approach angle

From images (Photos 6 and 7) of the aircraft at just before the accident and around 12:00 of the day shot by camera A from south side at its final approach on Runway 27 of Yao Airport, presuming that it was approaching toward the aiming point marking on the final approach course, the approach angle were about 5.3° and about 3.6°, respectively.



Photo 6 – the aircraft in the approach (at just before the accident)



Photo 7 – the aircraft in the approach (around 12:00)

(2) Estimation of the speed

Based on the image (Photo 8) of the aircraft just after the execution of a go-around taken by the camera B from south side of Runway A, assuming that it was flying over the centerline of the runway, the estimated groundspeed just after its execution of a go-around derived from its flight distance and the time was about 58 kt.

(3) Estimation of the altitude

Based on the image (Photo 9) of the aircraft just before the crash taken by the camera C from the north side, its estimated the highest altitude prior to the crash was about 38 m.



Photo 8 - the aircraft just after the execution of go-around (sequence photographs)

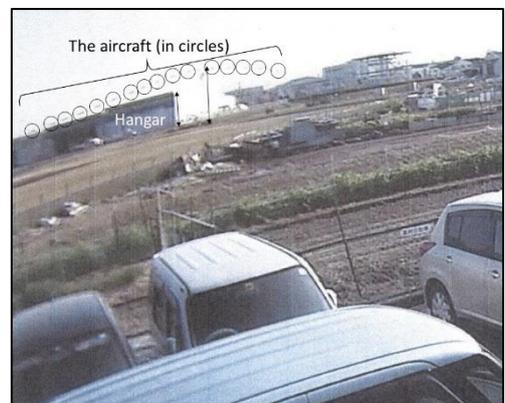


Photo 9 - the Aircraft just before the crash (sequence photographs)

2.11 Additional Information

2.11.1 The Characteristics of the Aircraft

According to the statement of acquaintance A, the characteristics of the aircraft were as follows:

He is a pilot who has 25,000 hours in total flight hours flying from small aircraft to large one and has about 20 to 30 hours to fly Mooney. As for the Mooney, because seats are low and a reach to the rudder pedals are long, he felt hard to look forward. Because the rubber is used in the shock absorber of the landing gears, Mooney apt to bounce. Once bounced, as he lowers a nose to see a runway, it tends to porpoising^{*2}; therefore, he landed as pitching up, reducing the speed and having the stall warning horn sounding. He had experienced a stall in the air when he flew a Mooney, and once it entered a complete stall, it rolled to left and went into spin.

^{*2} “Porpoising” is a state in which, due to an improper recovery operation, the nose landing gear of an aircraft touches down before the main landing gear, causing it to perform a successive undulating motion similar to that of a porpoise leaping into the air then diving back into the sea head first.

2.11.2 Information on the Experience of the Captain

According to the statement of acquaintance A, the information on the captain was as follows:

Acquaintance A got acquainted with the captain about three years ago and was sometimes talking about upcoming on the phone. It was the fourth time to have met him on the day of the accident. It was one year ago that he met the captain last time, and he witnessed the delivery from the former owner of the aircraft which the captain bought.

Since the aircraft was difficult to maneuver, by the suggestion of acquaintance A, the captain and a pilot who accompanied executed the take-off and landing trainings at Yao Airport for their familiarizations prior to a ferry flight of the aircraft to Kohnan Airport. To execute a training, the trainee usually sits in the left pilot seat which is the seat for a captain. At the time, both of them sat in the left pilot seat alternately, acquaintance A who was a captain at that time sat in the right pilot seat to be present for five times of each of take-off and landing trainings. At the first landing, as both of them resulted in porpoising, acquaintance A executed a go-around, but at last, they could land by themselves.

Later, the captain had reported his update of the taking airworthiness inspection at Kumamoto Airport and the trip to Naha Airport to him.

2.11.3 Information on Passenger A

(1) Information on passenger A according to eyewitness C

Passenger A had started his training to obtain commercial pilot certificate at operator C of Yao Airport since September 2013, flew for about 92 hours as trainings and planned to submit an application for an examination of Civil Aviation Bureau (CAB) in April 2016 and take the examination in May of the same year. His pilot skill was average, but he had a tendency to be overstressing and focus only on the points which someone had just made a remark on him. His trainings were done by Cessna 172.

(2) Information on the training records

The training for passenger A to obtain commercial pilot certificate was planned 59 times and 100 hours. About the progress of the training, the latest training was done on March 5. His training had executed 64 times and for 92 hours 11 minutes, including 17 lessons as supplementary, and completed up to the 47th lesson out of the planned 59 lessons. The frequency for each year was twice a month from 2013 to 2015 and once a month for 2016. The flight instructor's records had the remarks of his tendency to be overstressing from the initiation training to the latest training.

2.11.4 Situation when the Captain landed at Yao Airport

On the day of the accident, according to the statement of a person who sat in the right pilot seat while the captain maneuvered the aircraft in the left pilot seat and communicated with air traffic control from Kohnan Airport to Yao Airport, the situation of landing at Yao Airport was as follows:

The appearance of PAPI was three whites/one red when the aircraft was flying from the base leg to the final approach course, two whites/two reds when the flight of the aircraft was stable, one white/three reds just before crossing the airport border and two whites/two reds at the runway threshold.

Where the aircraft touched down was just about to pass through Runway B (13 / 31), it was difficult to see the front; therefore he did not know the positional relation to the aiming point

marking, but he thought that it landed on the good spot.

2.11.5 Information on the Refueling

According to the statement of a person who refueled the aircraft, the aircraft was refueled up to full by the captain's instruction around 12:15 on the day of the accident.

2.11.6 Information relating to the Maneuvering

2.11.6.1 Description of the Flight Manual

(1) Normal Procedures

The Flight Manual of the aircraft "*Chapter 4; Operation Manual during normal situation*" has following descriptions (abstract):

4-2-5 Stall

The stall characteristics of the airplane are conventional and rapid recovery from a stall is effected by releasing elevator back pressure and applying power.

The stall warning horn will give the first indication of the approaching stall and this may be followed by downward pitching, aerodynamic buffeting, rapid decay of control effectiveness, and/or a rapid loss of altitude with the control wheel aft. Upon recognizing the approaching stall, recover by releasing elevator back pressure and applying power.

4-2-6 Spins

Intentional spins are not permitted in this airplane; however, if stall recovery is delayed or if the airplane is held in the stall, in an uncoordinated manner, the airplane will likely to go into spin. A spin is a stall combined with rotation, with the airplane rotating downward in a descending corkscrew-like path.

WARNING: Up to 2000 feet of altitude may be lost in a one-turn spin and recovery; therefore stalls at low altitude are extremely critical.

The wings will be near vertical at about the first quarter turn of the spin. At about the half turn point, the wings are approaching level but, now, the nose will be very low--approaching vertical. After one full turn has been completed, the nose will come up somewhat, but will remain well below the horizon. The rate of rotation during the first portion of the spin is quite rapid and occupants of the aircraft will likely become disoriented.

Besides, the Flight Manual of the aircraft does not include the description for go-around procedures.

(2) Stall Speed

According to the Flight Manual "*Chapter 5; Performance 5-4 Airspeed and Stall Speed*", the stall speed at power-off with flaps/gear down is 49 kt (condition; forward CG location, power off).

2.11.6.2 Description in the References

(1) The following description is included in the "Airplane operation textbook" (the third edition, Japan Aviation Promotion Foundation, issue on May 1, 2013) for go-around procedures (abstract):

4.4 Go-around

(omit)

(1) *Go-around maneuver and the guidelines*

(omit)

- a. *While maintaining the direction, increase the power to full. Maintain the safe rising attitude for the pitch.*

Smoothly open the throttle to the full open position while simultaneously holding the control column to maintain the nose in the safe climb attitude and maintain the direction with the rudder in order that the nose does not yaw left or right. When doing so, attention must be paid to the airspeed and the attitude.

- b. *Maintain the safe rising and conduct trim control*^{*3}.

The trim is already adjusted in order that it is suitable for landing on the final approach; accordingly, the column pressure changes if the power and airspeed increase. Conduct trim control to remove this pressure while maintaining the safe climb attitude.

- c. *When the aircraft reaches the safe attitude and safe speed, retract the gears.*

After the trim control is completed and the airplane reaches the safe altitude and speed, retract the gears. Gear retract operation should be done after the safe climb attitude is established and the airplane is no longer sinking and must not be done in a hasty manner. During operation, sufficient attention must be paid to the airspeed in order that the airplane does not stall.

- d. *When the airplane reaches a suitable altitude (altitude prescribed in the airplane flight manual), retract flaps.*

If flaps were extended, retract the flaps. When retracting the flaps, be sure to thoroughly comply with the altitude limit and the speed limit. When flaps are retracted, the lift (and drag) reduces and the nose down. The altitude also apt to lower. Therefore, apply plenty of back pressure to the control column (pull the control column backward for support) and maintain the climb attitude.

- e. *Set the airplane to straight and climbing and control the trim again.*

Control the trim again to the climbing configurations, establish the climb attitude, and fly according to the following plan.

A go-around requires quick and continuous operations; accordingly, the pitch attitude and airspeed tend to be disrupted in a hurry. Be sure not to panic, keep calm, and thoroughly follow the correct procedures. Report to the control tower after a safe attitude is established. Since the gears and the flaps on the airplane, the nose tends to up in full power. Therefore, thoroughly maintain the flight control and first attempt to stabilize the attitude of airplane.

- (2) Regarding weight, CG location and Stall, "Aerodynamics Propeller Plane" (the 2nd edition, issued and revised on September 15, 2006) issued by Japan Aeronautical Engineers' Association has following descriptions:

Chapter 14 Weight and CG Location

The weight and allowable range for CG location are severely limited from the views of airframe strength and the controllability, and since these are indicated as the operational limit for an airworthiness, at stage to prepare for a flight, it must be required to confirm these values are within an allowable range for all of flight condition.

Chapter 14.4 Loading limitations

^{*3} "Trim control" refers to the reduction of the steering force on the piloting system and stabilization of the flight attitude by adjusting the aerodynamic force against the control surface by an independent operation system.

The limit can be exceeded depending on the way to load. For those cases, they are required to limit the loading weight within the limits and reduce weight or change the position of loading in order that the CG location would be within an allowable range.

a. weight limitations

As for the small plane, it will require cares since there many cases that the take-off weight exceeds the limit weight if the seats are full and fuel is full.

(omit)

c. the case that the CG is located further aft

An aircraft fully occupied with passengers can easily exceed not just the weight but also the aft limit of the allowable range for CG location. Therefore, measures must be taken to keep the CG location within the allowable range such as by leaving one of rear seats vacant or measuring the weight of all people who are boarding and assigning lighter passengers to the rear seats. If the CG location is near the aft limit of the allowable range, stability and controllability can still be maintained through careful piloting. However, the fore portion becomes lighter than desired, highly caused the following tendencies such as “unstable ground-taxing”, “excessive rotation rate during takeoff”, “ reduced stability at low airspeeds”, “risk of stall”, and “ risk of spin and greater difficulty recovering from spin”, and it is not favorable.

(omit)

Regarding to loading onto a small plane, important notes are as follows:

- (a) When a tank was filled to its limit, it is not possible to board number of passengers to fill all of the fitted seats and load up to the weight limit of loading.*
- (b) When the passengers are on board up to its capacity, the amount of fuel would be less than its fill and distance and time of the flight would be shortened.*
- (c) The CG location shall be kept within the allowable range for every phases including consumed fuel during a flight.*
- (d) During a flight, check a locational relation of CG of the airplane you are flying, acknowledge the different controllability depending on the CG location at near aft limit or fore limit and take appropriate countermeasures.*

Chapter 15 Type of Stall and Maximum Movement of Flight

15.1 Type of Stall

As following should be understood as the common characteristic of the stall; the stall is essentially generated when angle of attack onto a wing exceeds a stall angle, as an aileron loses its effects at first of three axis control, but the rudder could have an effect to the last of all, when the higher the engine outputs, smaller the stall speed would be, but the bigger the attitude at the time of stall and the greater the change in altitude, when the CG location is aft, it apt to enter stall and is difficult to be recovered.

(omit)

As for the power-on stall at the time of high power, the stall speed will be smaller than the power-off stall, but it tends to be generated when a pilot attempts to gain a climbing angle causing an excessive pitch-up during the climbing phase right after the take-off. At this stage, if you cut suddenly off engine or if engine had a failure, it could be great risk since the aircraft might suddenly generate spin or complete stall which is hard to recover.

Furthermore, when the CG location is near the aft limit, there will be insufficient generation of the nose-down moment even it is getting close to the stall, and the delayed maneuver at the initial stage of stall might cause an unrecoverable flat-spin.

The flat spin is the type of spin for an airframe to rotate at almost horizontal position and cause a sudden drop. Since this spin causes stall at a horizontal tail or a vertical tail at the same time and as it loses completely the effects of the elevator or rudder, this spin is very difficult one to recover a control by maneuvering, and requires great attentions because it could apt to be generated when the CG location is near aft limit or when multi-engine plane failed one of the engines.

2.11.7 Descriptions of Aviation Act and others

- (1) Descriptions of specific pilot competence review from Civil Aeronautics Act (abstract)

Article 71-3; Unless he/she who holds a competence certificate has to be examined and pass the examination in order to confirm whether he/she has and maintains his/her aeronautical knowledge and aeronautical proficiency especially necessary for piloting an aircraft (hereinafter referred to as “specific pilot competence”), a person who holds a competence certificate and an aviation medical certificate onboard an aircraft of category that indicated on the competence certificate shall not perform the following duties:

1 Any operation onboard an aircraft

Article 71-4; The provision of paragraph 1 of the preceding article means a pilotage for a person who holds a pilot competence certificate and an aviation medical certificate, but does not pass the examination pursuant to the provision of that paragraph within the period under that paragraph onboard an aircraft that indicated on the said competence certificate, and it shall not apply to the pilotage training performed under the supervision of a person who holds a competence certificate which qualifies his/her for the pilotage of the aircraft used as a captain and an aviation medical certificate.

- (2) Descriptions of the Preflight Checks by the Captain from Civil Aeronautics Act and Ordinances for Enforcement of the Civil Aeronautics Act (abstract)

Article 73-2; The pilot in command shall not start an aircraft, unless he/she has confirmed that the aircraft has no problems for flight and the necessary preparation for air navigation has been completed, pursuant to the provision of Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism.

Article 164-14; Matters that must be confirmed by the pilot in command pursuant to Article 73-2 of the Act are as listed below:

(omit)

2. Take-off weight, landing weight, location of the center of gravity and weight distribution

2.11.8 Information on PAPI

PAPI which is placed on Runway 27 at 263 m from the runway threshold to inside on its left side is four-lamp type and has a nominal approach angle of 4.5°. Each lamp is set at 4°, 4.33°, 4.67° and 5° from the outside, and for the higher of each angle, it shows white and for the lower of each angle shows red.

3. ANALYSIS

3.1 Qualifications of Personnel

The captain and passenger A had valid airman competence certificates and valid aviation medical certificates. As described in 2.4 (2), the specific pilot competence certificate for passenger A was passed the expiration date, but as described in 2.11.7 (1), it is highly probable that passenger A could operate the training flight of the accident under the supervision of the captain.

3.2 Airworthiness Certificate

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

3.3 Relation to Meteorological Conditions

As described in 2.6, it is highly probable that the weather conditions at the time of accident around Yao Airport were not related to the flight of the aircraft.

3.4 Flight Situation of the Aircraft

As described in 2.1 and 2.11.5, it is highly probable that the aircraft took off from Kohnan Airport at 11:00 and landed at Yao Airport at 12:00 and refueled up to full with the captain sat in the left pilot seat to maneuver. As described in 2.1.3 (5), it is probable that the captain and three passengers decided to make a round trip flight on the aircraft to Kobe Airport by the natural course of the conversation at the apron.

As described in 2.1, 2.1.1 and 2.8, as the captain sat in the right pilot seat, passenger A in the left pilot seat, passenger B in the left rear seat, and passenger C in the right rear seat, the aircraft took off from Runway 27 of Kobe Airport at 16:03. As described in 2.1.1, 2.1.2 (3) and 2.1.3 (1), it is highly probable that the aircraft turned to the left after the take-off, heading to Yao Airport, entered the left down-wind leg of Runway 27 from Asaka and attempted to land.

3.5 Situation of the Crash

Based on the description in 2.1.3 (1), it is probable that the aircraft attempted to land, touched down once and then bounced. It is probable that the aircraft lowered its body slightly after its wheels lifted, then it took the attitude to refloat and it reported a go-around in the front of the tower, and then it was added engine power. As described in 2.10.2 (2), it is probable that the groundspeed of the aircraft was approximately 58 kt just after initiating a go-around, based on the wind information as described in 2.6, the airspeed was approximately 65 kt.

Based on the descriptions in 2.1.3 (1) through (4), it is highly probable that the aircraft started to nose up but it did not stop, the posture resulted in abnormal high nose-up and the speed was reduced. And then, it is highly probable that the posture was returned to be leveled, but as the aircraft started to sink, it turned to left quickly and crashed. As described in 2.10.2 (3), it is probable that the highest altitude prior to the crash of the aircraft was about 38 m above ground.

As for the situation of the crash mentioned above, it is highly probable that the aircraft bounced while landing and attempted to a go-around; consequently it resulted in the abnormal nose-up posture at low altitude, stayed on, slowed speed, went into stall and spin as described in 2.11.6.1 (1) and 2.11.6.2 (2), and then crashed.

Based on the description in 2.11.6.1 (1), in order to prevent this kind of crash, it is important to maintain a safe climbing attitude, but when failed it and approaching to stall, it is necessary to down the elevators to avoid stall. However, it is somewhat likely that as for the accident, as the aircraft could not keep the posture appropriately during the go-around, its resulting abnormal nose-up posture and in spite of the imminent stall situation it did not take any evasive action, and it is highly probable that it was stalled, went into spin immediately, as it did not have enough margin to recover the posture due to its low altitude, and crashed.

Based on the description in 2.7.1 and 2.7.2, it is highly probable that the situation when the aircraft crashed on the ground was as it was rolling to left (rotating around the longitudinal axis), the left wing tip hit the runway at first, and then, the spinner crashed onto the shoulder with an posture of approximately -120° in pitch angle (motion around left and right axes) and approximately 30° in roll angle, and the propeller shaft was fractured; accordingly, the engine part was pushed up from the bottom and the whole leading edge of the right wing was crashed onto the grassland. As described in 2.1.3 (2), since two impact sounds were generated, it is highly probable that the aircraft was bounced in reaction after the crash on the ground above mentioned, the whole airframe crashed onto the grassland again and resulted in the condition of the airframe described in 2.7.1. (See Figure 5)

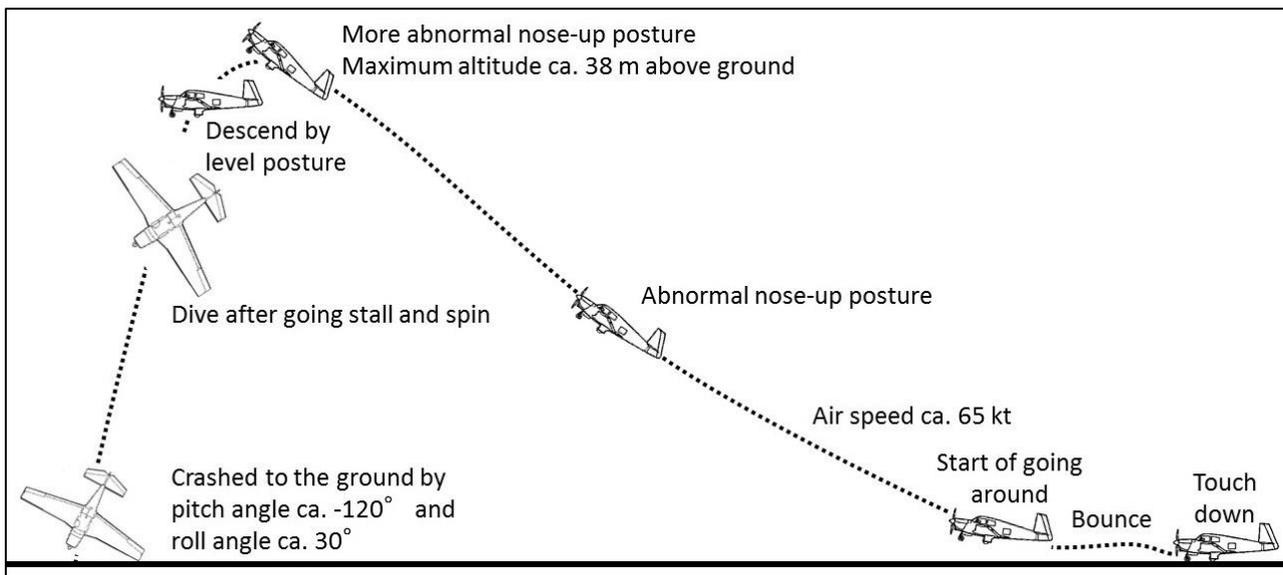


Figure 5 – situation of the crash (conceptual figure)

3.6 Preflight Check by the Captain

As described in 2.5.2, it is highly probable that the weight of the aircraft was 2,726 lb which exceeded the maximum weight by 151 lb at take-off at Yao Airport; on the other hand, the weight was 2,708 lb exceeded the maximum weight by 133 lb and the CG location was 0.52 in aft for the aft limit corresponding to the maximum weight at take-off at Kobe Airport. As described in 3.4, it is probable that why the captain and three passenger decided the round trip flight to Kobe Airport with the aircraft, it was decided by the natural course of the conversation. Later, it is probable that the captain made a round trip flight with insufficient preflight check or without any check as described in 2.11.7 (2).

It is possible that the overweight and the aft CG location for the aft limit corresponding to the maximum weight as described in 2.11.6.2 (2) had impacts on the controllability and the stability and other things, and in this accident, contributed to the bounce on touchdown, the abnormal nose-up posture after the go-around, the decreased stability at the low speed flight and the occurrence of stall

and spin.

3.7 Bounce of the Aircraft

As described in 2.10.2 (1) and 2.11.8, when the aircraft had approached toward the aiming point marking on the final approach course of Runway 27 of Yao Airport, it is somewhat likely that its final approach was approximately 5.3° which is deeper than the nominated approach angle 4.5° for the runway by 0.8° and was so deep that where all four white lamps of PAPI could be visible.

Regarding the bounce the aircraft made, as described in 2.11.6.2 (2), it is somewhat likely that the approach taking deep approach angle like described above in the decreased stability situation at low speed affected by the aft CG location contributed to the bounce on touchdown.

3.8 Experience of the Captain

As described in 2.4 (1), it was approximately one year and five months since the captain had obtained the private pilot certificate and his total flight time were 138 hours and 47 minutes; however, as he spent almost all his flight time on the aircraft after starting his flight and had landed it for 53 times, it is probable that he was well familiarized with it at some level. It is unable to determine the captain's maneuvering experience sitting on the right pilot seat.

As described in 2.10.2 (1), 2.11.4 and 2.11.8, when the aircraft which the captain maneuvered landed at around 12:00, it is highly probable that the approach angle was high to enter the final approach course, low on the path, and appropriate angle before the landing. Based on this situation, it is somewhat likely that the captain approached and landed as modifying the height of an approach course.

3.9 Experience of Passenger A

As described in 2.4 (2) and 2.11.3, it is highly probable that passenger A had a long experiences and well familiarized with Yao Airport since he had received about 92 hour training to obtain the commercial pilot certificate at operator C based on Yao Airport; moreover, his total flight time were 279 hours and 47 minutes, and he had 12 years and 10 months experience acquiring a private pilot certificate.

On the other hand, as described in 2.4 (2), it is highly probable that the passenger A was not familiar with the aircraft as no experience to fly the type of the aircraft. And, as he had not maneuvered the airplane equipped with retractable landing gears for about one year and eight months, it is probable that he was not familiar with controlling an aircraft which had retractable landing gears to execute a go-around. In addition, as described in 3.4, since the flight with the aircraft was decided in the natural course of the conversation, it is somewhat likely that passenger A did not have time to study about the characteristics and the maneuvering of the aircraft prior to the flight, and he did not have the sufficient knowledge.

As described in 2.11.3, as passenger A planned to take an examination of CAB about two months later, the frequency of training was reduced to once a month and he had received the remark for his tendency to concentrate on a single point at up to the latest training, based on these situation, it is somewhat likely that if he had a chance to fly, he would take the chance to use it fully.

3.10 Pilot Maneuvering and Air Traffic Control Communicator up to Go-Around

Based on the descriptions in 2.1 and 2.11.4, it is highly probable that air traffic control communicators on board the aircraft for the flights from Kohnan Airport to Yao Airport, from Yao

Airport to Kobe Airport and from Kobe Airport to Yao Airport, were the captain, passenger C and passenger A who sat in the left pilot seat, except for the reporting of a go-around just before the accident.

Even though the aircraft could be maneuvered from both of the right pilot seat and the left one, it is somewhat likely that the one who was maneuvering from the time to the take-off from Kobe Airport up to the time to the go-around at Yao Airport was passenger A in the left pilot seat not the captain in the right pilot seat because, as described in 2.1 and 2.11.2, the pilot sitting in the left pilot seat normally for a captain was passenger A, and as described in 2.10.2 (1) and 2.11.4, the approach course was greatly differed from the one when the captain maneuvered to land and others, but it could not be identified.

3.11 The Situation from Go-Around to Crash

At the time of the go-around, as described in 2.11.6.2 (1), as “*the trim is already adjusted in order that it is suitable for landing on the final approach; accordingly, the column pressure changes if the power and airspeed increase,*” “*Since the gears and the flaps on the airplane, the nose tends to up in full power*”; moreover, since the aircraft had the overweight and the aft CG location, it is probable that greatly forward pushing the control column would require to suppress the nose-up movement of the aircraft, and the maneuvering would be difficult.

Concerning positions of the elevator trim in middle of a total excursion as described in 2.7.1, it could not be determined either it stayed on that positions from the time to enter the final approach, or it was reset to the positions after the go-around.

At the time of the go-around, regarding that the aircraft climbed with abnormal nose-up posture, slowed as keeping the posture and could not avoid in spite of an imminent stall situation, it is somewhat likely that the captain or passenger A who maneuvered it could not suppress the excessive nose-up movement because it was exceeding the maneuverable range after adding engine output in the condition which was the overweight and the aft CG location during the go-around with strong tendency to nose-up and others. However, it could not be determined because all members of the aircraft on board were died.

3.12 Fire-fighting and Rescue Operations

Based on the descriptions in 2.1.3 (1) through (3) and 2.7.2 (1) and (3), it is probable that the fire of the aircraft was broke out as some kind of fire source like the heat from exhaust pipe and others, ignited the leaked fuel from the base of the right wing after the crash.

Regarding the fire-fighting and rescue operations of the accident as described in 2.9, it is highly probable that the actions were appropriate.

4. PROBABLE CAUSES

In this accident, the aircraft bounced while landing and attempted a go-around, and it made an abnormal nose-up continued and decelerated, and then the stall could not be avoid in a situation where it imminent; consequently, it is highly probable that it stalled and went into spin, and finally it had crashed.

Regarding the reason why the stall could not be avoid in the imminent situation, it is somewhat likely that the captain or passenger A who maneuvered the aircraft could not suppress the excessive nose-up movement because it was exceeding the maneuverable range and others. All members of the aircraft on board were died; accordingly, the investigation was unable to determine the causes.

Besides, the aircraft had overweight and aft CG location for the aft limit corresponding to the maximum weight. It is somewhat likely that these condition affected the controllability and the stability, and contributed to the bounce on touchdown, the abnormal nose-up posture during a go-around, the decreased stability at low speed flight and the occurrence of stall and spin.

5. SAFETY ACTIONS

5.1 Safety actions taken by Ministry of Land, Infrastructure, Transport and Tourism after the accident

5.1.1 Action taken by Civil Aviation Bureau

On March 28, 2016, after the occurrence of the accident, the Director of the Flight Standards Division and the Director of the Air worthiness Division, Aviation Safety and Security Department had issued the documents (Kokukuko No. 3366 and Kokukuki No.3632, March 28, 2016) to promote the warning notice to take all possible measures for securing the safety of operations via compliance of the procedures relating the operation, the reliable implementation of the inspection and maintenance of all airframes, compliance system, including the reconfirmation of the safety protocol at the landing, to the chairmen of Japan Aircraft Pilot Association, All Japan Air Transport and Service Association CO., LTD., Japan Aeronautic Association and AOPA-JAPAN to inform once again each operator who is an affiliated member of them.

5.1.2 Safety Actions taken by West Japan Civil Aviation Bureau and Yao Airport Office

West Japan Civil Aviation Bureau and Yao Airport Office implemented the following joint activities in April 2016 for all operators who has the aircraft parking at Yao Airport and the pilots of the visiting aircraft as the subject;

(1) Implementing the voluntary inspections to secure the safety by the operators;

- From April 4 through 10 as an enhancing period, instructed operators, and implemented the voluntary inspections such as before take-off procedures by a pilot and a dispatcher, procedure to confirm a maintenance status, maintenance procedure.
- These inspection status of the operator were confirmed from April 7 through 9.

(2) Holding safety seminar

- On April 23, at Yao Airport, a safety seminar for small airplanes was held with 63 private pilots, and such as the safety flight thoroughly, appropriate acquisition of business permit were promoted.

(3) Action taken for visiting aircraft

- April 23 and 24, guidance to reconfirm the safety flight was implemented to the visiting aircraft which would take-off and land at Yao Airport.

Appendix: Three Angle View of Mooney M20C

Unit: m

