AVIATION INVESTIGATION REPORT
A01P0296

ACCIDENT

PACIFIC PROFESSIONAL VISUAL FLIGHT TRAINING
CESSNA 152 C-GJKE
BOUNDARY BAY AIRPORT, BRITISH COLUMBIA
03 DECEMBER 2001

Aviation Investigation Report

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Summary

At 1510 Pacific Standard Time, a Cessna 152, C-GJKE, serial number 152-84864, with a solo student pilot on board, was departing Runway 12 at Boundary Bay Airport with the intention to carry out circuits. As the aircraft lifted off the runway, it immediately executed a severe and uncommanded left yaw. During the short duration of the flight, the pilot was unable to apply right rudder control. Left rudder control was available and appeared to operate normally. The pilot was only able to partially counteract the left yaw through aileron control input. As the aircraft climbed to about 80 feet above ground level (agl), it continued in a left turn for about 180°. The pilot declared an emergency, informed the tower of the directional control difficulty, and attempted to land on Runway 25. The aircraft touched down obliquely on Runway 25 and ran off into the grass on a northwesterly heading. Tire tracks in the grass indicated that the aircraft was yawed to the left at touch down. The aircraft went through a swale in the field which caused the nose gear to collapse, resulting in the aircraft stopping upright but resting on the nose. The local city fire department responded; there was no injury or fire. The aircraft had flown earlier in the day with no control difficulties reported. Winds at the time of take-off were light and variable.

Ce rapport est également disponible en français.

Other Factual Information

The student pilot was commencing his second solo flight as part of the training program to obtain a private pilot licence. He held a valid student pilot permit - aeroplane, and had accumulated about 30 hours of total flight time. While this amount of experience exceeds the normal amount for commencement of the solo flight stage of a private pilot training program, an administration delay had resulted in more training being completed. The pilot was regarded as an above-average student pilot. The type of footwear worn by the pilot, as well as objects falling from the unoccupied passenger seat and jamming the rudder pedals were considered as possible sources for the directional difficulty problem. However, further investigation, observations, and discussions discounted these possibilities as unlikely.

General area weather at the time of the accident was an overcast condition made up of multiple cloud layers beginning at 2500 feet agl with calm winds and 20 miles visibility. Winds at Boundary Bay Airport at the time of departure were 070° magnetic at three knots. Weather is not considered to have played a role in this accident.

Following a previous flight on the day of the accident, the aircraft had remained parked on the apron at the airport terminal. There was no information or indication that the aircraft had been subjected to any abnormal weather disturbances and had not been towed or otherwise handled on the ground. The pilot completed a walk-around inspection, had the aircraft refuelled, and completed the taxi and pre-flight checks. No abnormalities were noted. During the take-off roll, the pilot applied right rudder to maintain runway heading, and the aircraft tracked straight down the runway centre line and lifted off at about 60 knots. The take-off roll was normal until lift-off.

The aircraft was primarily used for pilot training throughout its history. It was certificated, equipped, and maintained in accordance with existing regulations and approved procedures. Records indicate that the aircraft had accumulated about 15 120 hours of air time. The previous maintenance inspection was a 50-hour inspection, completed about 25 hours of air time before the accident. The aircraft was due for a 200-hour inspection in another 25 hours. Maintenance records for the aircraft indicate two previous occurrences of nosewheel damage. It was recorded in 1992 (three years after the second incident) that the right hand (RH) nosewheel steering tube assembly (part number 0543022-4) was replaced with a used part. These parts are not serialized and are maintained as an “on-condition” item, meaning that they may be used until they no longer function as designed. There is no means of inspection to determine the internal condition of the nose gear steering tube assemblies. The replacement RH nose gear steering tube assembly may have come from an accident aircraft, and internal damage could have existed as a latent unsafe condition. Testing confirmed that even in the damaged condition as found, the unit withstood design loads.

The aircraft is equipped with two nose gear steering tube assemblies, a right and a left. The purpose of these assemblies is to allow rudder operation to continue when the nosewheel centres and locks upon oleo extension at lift-off. These assemblies are similar in appearance to a shock absorber and incorporate a built-in, pre-load spring which operates when the unit is placed under tension. Each assembly connects the left or right rudder pedal torque tube to its respective side of the nose gear steering collar. Each rudder pedal torque tube is also connected aft to the rudder via cables, which form a closed loop system (Appendix A).

After the accident, initial examination of the aircraft flight control systems did not reveal any anomalies in their operation. In particular, the rudder itself, the rudder travel limit stops, the rudder control pedals, the associated control cables and the nosewheel steering limit stops were all intact. Further disassembly and examination revealed that the RH nosewheel steering tube assembly (part number 0543022-4) did not operate in the same fashion as the left hand (LH) nosewheel steering tube assembly (part number 0543022-3).

It was noted that the RH assembly could not be extended against the internal spring pre-load pressure, an action necessary to apply right rudder when airborne with the nosewheel in the normal centred and locked position. Dissection of both nosewheel steering tube assemblies revealed that the inner spring retainer washer on the end of the rod section in the RH assembly was saucer shaped and positioned on the opposite side of an annular crimp in the outer tube section when compared to the same part in the LH assembly (see Figure 1). From this position, it could not return to its normal position and operation. If this condition pre-existed, it would not prevent steering action on the ground, yet it would mechanically prevent the application of right rudder when the nose oleo extended at lift-off and engaged the nosewheel centring and locking cam. The left rudder would operate normally since the RH nosewheel steering tube assembly could still operate in the compression mode. Furthermore, in this condition, the automatic centring action of the nose gear as the aircraft lifted off would have resulted in the application of two to four degrees of left rudder deflection. This is due to the left hand rudder centring spring taking up the slack introduced in the right hand rudder cable by the right hand rudder pedal being moved aft of its normal position due to the shortened length of the RH nosewheel steering tube assembly.

The possibility of the washer in the RH nosewheel steering tube being pushed past the crimp during a ground operation was examined from two perspectives. The first scenario looked at mishandling by the pilot. Research determined that in accordance with design specifications, a pilot-induced force in excess of 300 pounds on the left rudder pedal while the nosewheel was turned to the right (as if caught in a rut) would be required to force the washer in the RH nosewheel steering tube assembly past the crimp without exceeding any built-in stops in the system. The nosewheel steering tube assemblies were tested and analysed at the TSB Engineering Branch, and even with a saucer shaped washer, the RH unit withstood design loads during testing. Surface inspections did not reveal any unexpected wear markings. Metallurgical testing conducted by the TSB Engineering Branch confirmed that all parts met design specifications for type of material, dimensions and hardness. In addition, the airport apron area used for aircraft parking as well as some of the taxiways were examined for surface

condition; no significant irregularities were noted. There was also no information indicating that excessive pilot-induced forces had been applied or required during ground operations subsequent to the previous landing or leading up to the accident flight.

The second scenario considered the possibility of induced damage as a result of towing. This scenario was discounted for two reasons: firstly, there was no information to indicate that the aircraft had been towed during the applicable time period, and secondly, there was no damage to the nosewheel steering stops which should have been evident had the limits been exceeded.

A search of relevant part numbers in Service Difficulty Reports (SDR) on the Transport Canada (TC) and the US Federal Aviation Administration databases produced three reports, one of which described a similar situation with the operation of the nosewheel steering tube assemblies (TC control # US1988022500012). An accident did not occur on the subject flight; no additional information is available. Two hundred and twenty one occurrences related to C152 directional control retrieved from the TSB and NTSB (United States) databases were also reviewed; four were of interest, however, none elaborated on any examination of the nosewheel steering tube assemblies for correct operation.

Analysis

It is unlikely that the average person could apply the amount of force to a rudder pedal (with one foot) required to push the washer in the nosewheel steering tube assembly past the crimp. Additionally, the taxiway and apron in the parking area did not appear to be conducive to jamming the nosewheel.

It was hypothesized that the RH nosewheel steering tube assembly condition may have pre-existed. If it did, the damage would have occurred following the previous landing (two hours earlier) since no control anomalies were reported by the crew of the previous flight. A mechanical analysis was conducted to determine whether the condition in which the RH nosewheel steering tube assembly was found could have existed prior to the take-off. Testing was conducted on an aircraft with the RH nosewheel steering tube assembly modified to simulate the condition of the unit as found on the accident aircraft. Test conditions confirmed the description of the aircraft control operations both on the ground and in flight. However, the hypothesis did not explain the severity of the left yaw experienced by the pilot. Controlled and flyable side-slip manoeuvres, where rudder deflections exceed the two to four-degree deflection determined in the hypothesis, are routinely used in the training environment and should have been within the ability of the pilot to control.

With the current knowledge and information available, an explanation for the development of this hypothesized condition was not determined. Therefore, it could not be concluded whether the anomaly in the RH nose gear steering tube assembly was the result of impact damage or whether the condition was pre-existing.

The following TSB Engineering Branch report was completed:

LP 003/2002 – Failure Analysis, Nose Gear Steering Tube

Findings as to Causes and Contributing Factors

1. The aircraft exhibited adverse flight characteristics at lift-off which could not be counteracted because of the restricted movement of the right rudder when airborne. Flight characteristics of the aircraft were beyond the ability of the pilot to control.

Other Findings

1. Even in the damaged condition as found, the washer in the RH nosewheel steering tube assembly withstood design loads during testing.

2. It could not be determined whether the anomaly in the RH nose gear steering tube assembly was the result of impact damage or whether the condition was pre-existing. If it was pre-existing, an explanation for the development of this anomaly could not be determined.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 05 December 2002.

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Appendix A

Schematics of nosewheel steering tube assemblies and connections to nosewheel strut and rudder pedal torque tubes.