
Tail scrape on takeoff, Boeing 737-3YO, G-BWJA, 19 May 1997

Micro-summary: A brisk rotation resulted in a slight tail scrape on takeoff.

Event Date: 1997-05-19 at 1355 UTC

Investigative Body: Aircraft Accident Investigation Board (AAIB), United Kingdom

Investigative Body's Web Site: <http://www.aaib.dft.gov/uk/>

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Boeing 737-3YO, G-BWJA, 19 May 1997

AAIB Bulletin No: 12/1997

Ref: EW/C97/5/6 Category: 1.1

Aircraft Type and Registration:	Boeing 737-3YO, G-BWJA
No & Type of Engines:	2 CFM56-3B2 turbofan engines
Year of Manufacture:	1989
Date & Time (UTC):	19 May 1997 at 1355 hrs
Location:	London Luton Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 5 - Passengers - 51
Injuries:	Crew - None - Passengers - None
Nature of Damage:	Rear water drain mast damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	8,346 hours (of which 2,842 were on type) Last 90 days - 200 hours Last 28 days - 82 hours
Information Source:	AAIB Field Investigation

History of flight

The first officer was undergoing his first week of line training and had already completed 10 sectors, all under the supervision of the same Training Captain who was the commander on the incident flight; following satisfactory progress, the 'screen' first officer had been released after 8 sectors. The commander had assessed the previous 7 take offs, carried out by the first officer, as satisfactory. This flight was the first of the day for the crew. The weather was reasonable with light rain and a surface wind of 180°/08 kt; Runway 08 was in use.

Flap 1 was used for take off and the passengers were distributed evenly throughout the cabin. The ground roll was normal and the first officer commenced rotation at the commander's call of

"Rotate"; this had been calculated as 126 kt and was coincident with V1. The commander assessed that the aircraft nose pitched up more rapidly than normal but not excessively so and he considered it as a result of the light take-off weight. Subsequently, the climb was normal and the handling pilot levelled the aircraft at cruise flight level. However, one of the cabin attendants who had been seated at the rear of the aircraft had noted an unusual noise at take off and, during the cruise, reported the fact to the commander. There had been no comment from ATC at Luton and a check of the cockpit indications revealed no adverse indications; the pressurisation had performed normally during the climb and level off. Therefore, the commander decided to continue the flight to Edinburgh and the first officer made a normal landing at 1442 hrs.

After arrival on the stand, the commander checked the rear of the aircraft and noted that the water drain mast had scrape marks. He postulated that this had occurred on take off from Luton and informed the aircraft ground engineers. Checks of the airframe confirmed the scrape marks on the drain mast but no other damage.

Flight Data Recorder

The Flight Data Recorder (FDR) was removed from the aircraft and replayed. The Cockpit Voice Recorder (CVR) was not removed as the incident had been recorded over.

The FDR data showed that the aircraft had commenced take off at 1355 hrs on a heading of 083°M with Flap 1 selected. Throughout the take-off roll, left rudder of between 2° and 4° was maintained. The elevator surface positions remained at approximately 3° trailing edge down until a speed of 125 kt was reached. Then, over the next one and a half seconds, the elevator surfaces were raised to between 9° and 11° trailing edge up. This position was held for the next two seconds during which the pitch attitude increased from 1.4° to 12.8° nose up; a peak rate of change of pitch of 9° per second was recorded. During this time, the air/ground sensor indicated main gear oleo extension, the aircraft started a slight roll to the left and the airspeed increased to 137 kt. In the next second, a peak aircraft pitch attitude of 16° nose up was recorded. The left roll reached a maximum of 3.9°, before the aircraft returned to wings level.

The aircraft pitch then reduced to between 13.5° and 14° as the aircraft accelerated through an airspeed of 143 kt. It subsequently climbed away at approximately 160 kt with a pitch attitude between 16° and 18°. No unusual readings were recorded on the vertical acceleration during the take off.

Aircraft Information

Boeing Commercial Airplane Group recommend that the Boeing 737 is rotated smoothly with one continuous motion at a rate of no more than approximately 3° per second up to target pitch attitude. Aft fuselage contact with the runway is possible if take-off attitudes higher than normal are reached before lift-off. The usual causes for aft fuselage contact with the runway are early rotation (prior to VR) and/ or a rapid rotation rate in excess of 3° per second. Flap position also affects aft fuselage to runway clearance during take off. For the Boeing 737-300, Flap 1 yields the least clearance and Boeing suggest in the Flight Crew training Manual that the use of Flap 5 be considered for take off at light gross weights; however, no definition of 'light gross weight' is given. With a normal rotation rate, the all-engine lift-off attitude is 9 to 10°.

Boeing were also asked for information on the pitch angles required for body contact. They provided the following information:

"Due to the close proximity of the drain mast to the airplane centreline, the drain mast will contact prior to the body of the aircraft with zero roll angle. In other words, the minimum roll angle necessary to produce damage to the drain mast is zero degrees.

For an extended oleo (13 inch stroke) with the airplane still on the ground, a pitch angle of 12.8 degrees is required to cause damage to the drain mast. At this pitch angle, there will be a 3.5 inch clearance between the ground and the aft body. A pitch angle of 13.4 degrees is required to contact the aft body.

For a static oleo (not fully compressed) with the airplane still on the ground, a pitch angle of 10.6 degrees is required to cause damage to the drain mast. At this pitch angle, there will be a 1.5 inch clearance between the ground and the aft body. A pitch angle of 10.8 degrees is required to contact the aft body.

Our experience indicates that most 737 tail strikes during takeoff occur with an extended oleo."

Company comments

The commander subsequently commented that the company "Free Seating" policy sometimes leads to minor trim differences between that indicated on the load sheet and what is actually required. At the time of the incident, the purser was only required to indicate to the commander if the passengers were not evenly spread throughout the cabin. Generally, from the commander's previous experience with this airline, passengers will fill the seats from the front but, on this occasion, they were evenly spread and therefore the control wheel force required may have been less than the first officer had previously experienced. Immediately after this incident, the company instituted a requirement for the purser to advise the commander of the exact seating on every flight.

The company policy is to use optimum flap performance and therefore the crew are presented with only one page of performance data for each runway end; on this occasion, the flap setting presented to the crew was Flap 1.

Summary

The aircraft take-off speeds were calculated correctly and rotation was initiated at VR. The rotation reached a peak of 9° per second but fortunately the pitch attitude prior to lift-off did not exceed 13°; the maximum pitch attitude of approximately 16° occurred shortly after lift-off. Damage to the drain mast occurred as a result of the pitch attitude reaching 12.8° with an extended oleo and the aircraft still on the ground. This pitch attitude followed from an excessive rotation rate of 9° per second.

At the time of the incident, the company policy of 'Free Seating' meant that the calculated take-off trim could have been inaccurate. For an inexperienced pilot, the tendency is to increase the rotation rate as confidence increases; an inaccurate trim position and a light aircraft would accentuate this tendency.

After this incident, the company introduced a positive seat check prior to each departure.