

Boeing 737-33V, G-EZYH

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INCIDENT

Aircraft Type and Registration:	Boeing 737-33V, G-EZYH	
No & Type of Engines:	2 CFM56-3C1 turbofan engines	
Year of Manufacture:	1998	
Date & Time (UTC):	30 October 2000 at 0703 hrs	
Location:	Liverpool Airport	
Type of Flight:	Public Transport	
Persons on Board:	Crew - 6	Passengers - 138
Injuries:	Crew - none	Passengers - none
Nature of Damage:	Damage to rear fuselage underside skin, drain masts and aerals	
Commander's Licence:	Airline Transport Pilots Licence	
Commander's Age:	55 years	
Commander's Flying Experience:	15,986 hours (of which 3,190 were on type)	
	Last 90 days - 153 hours	
	Last 28 days - 62 hours	
Information Source:	AAIB Field Investigation	

History of the flight

At about 0520 hrs, the crew reported at Liverpool Airport for the first sector of the day to London Luton Airport. The commander was an experienced Boeing 737 pilot but had flown only 153 hours as captain in the 300 series; he was to be the handling pilot as he was not permitted to let the first officer fly the sector in the prevailing weather conditions. A new member of the cabin staff, acting as supernumerary crew, occupied the jump seat for flight deck experience. Pre-flight preparations were routine and the passengers were boarding the aircraft when the commander was asked to

telephone Operations. He was told that the Chief Pilot had stopped all company operations at Luton due to adverse crosswind conditions, and he was to remain at Liverpool until further notice.

The commander decided to continue with the pre-flight preparations. He briefed the passengers about the weather conditions and the reason for the delay. One passenger decided not to fly and was taken off the aircraft; the Loadsheet was amended to reflect this.

The calculated takeoff weight was 50,624 kg (MTOW 56,472 kg) and the RTOW was 55,948 kg. A flexible thrust takeoff was planned for a weight of 53,020 kg at an assumed temperature of 42°C. The company policy was to use takeoff speeds related to the actual takeoff weight. For a Flap 1 take off these were : V1 = 134 kt; VR = 141 kt; V2 = 146 kt.

When the commander was told that Luton was open, he initiated pushback and taxied the aircraft to holding point 'A1' for Runway 27. The weather conditions were poor with a strong gusting wind and, during the control check, the commander noted that considerable force was needed to move the rudder pedals. After the ATC clearance had been received, the commander gave a comprehensive takeoff brief. The 'above the line' items of the takeoff checklist were then actioned.

Shortly before 0703 hrs the aircraft was cleared to takeoff and the surface wind was given as:

"320 DEGREES AT 23 MAXIMUM 30 KNOTS."

The aircraft was taxied onto the runway and the takeoff checks were completed.

The commander reported that, when the aircraft was lined up on the runway, he moved the power levers forward to the 40% position and, when the thrust was stable, selected TO/GA. He noted that the power had increased asymmetrically at first but he could not recall which engine had the lower power setting. The first officer recalled that it was the left engine which had lagged by 2 to 3% and that he had adjusted it.

As the aircraft accelerated, the commander was conscious of having to apply a significant amount of left rudder to maintain the centreline. This was combined with a large, into wind, control wheel deflection to maintain wings level. The normal calls were made and, in response to "ROTATE", he concentrated on raising the nose at a steady rate to a pitch attitude of 15°. The first officer reported that there was a positive initial rotation, followed by a slower rotation and then a further positive rotation. He considered that the rotation rate was higher than normal but was not excessively so. During the second part of the rotation, he felt the main landing gear leave the ground and, almost immediately afterwards, he felt what he described as "a secondary bump". The commander reported that he had to "work extremely hard" and when he felt the aircraft leave the ground he had concentrated on keeping the wings level while taking out the cross control which he had applied during the ground roll.

The workload was high during the initial climb and the first officer left it until they had cross-checked the altimeters at FL55 to ask the commander whether he had felt a "secondary bump on departure". The commander replied that he had but, although he didn't know what it was, he didn't think it was the tail striking the runway. The climb continued and the after takeoff checklist was actioned.

The crew appeared to be watching the pressurisation because the first officer remarked that it seemed to be working as the differential was increasing and the cabin was at 1,500 feet; he then

called FL100. Shortly after this a crew member, who had been seated at the rear of the aircraft, entered the flight deck and, in reply to a question from the first officer, said that she had heard the tail hitting the ground. After some discussion the commander decided to level at FL120 and called for the tail strike checklist. This entailed depressurising the aircraft so he opted to descend to FL100 to do this. The flight then continued to Luton where the aircraft made an uneventful landing.

Meteorology

The following METARS were issued from Liverpool Airport:

300620Z - 34026G39KT 6000 RA SCT008 BKN015 04/03 Q0959
300650Z - 31028G43KT 6000 RASN SCT010 BKN020 03/02 Q961
300720Z - 32024KT 6000 RASN SCT008 BKN015 03/02 Q964

A SPECI at 0704 hrs gave the surface wind as 32021G32KT and another at 0718 hrs as 32025G36KT

The current ATIS was 'Z'; it gave the runway condition as WET-WET-WET.

Flight Crew Training Manual

Advice is given under the heading Aft Fuselage Contact During Takeoff 737-300/400. It is reproduced, in part below:

"Due to the geometry of the 737-300 and 737-400, aft fuselage contact with the runway is possible if takeoff attitudes higher than normal are reached before liftoff.

The usual causes for aft fuselage contact with the runway during takeoff are early rotation (prior to VR) and/or a rapid rotation rate in excess of 3 degrees per second."

"Flap position also affects aft fuselage to runway clearance during takeoff. Flaps 1 (-300) and Flaps 5 (-400) takeoffs yield the least clearance."

"Beware of airplane attitude. Aft fuselage contact with the runway will occur at approximately 13 degrees (-300) and 11.5 degrees (-400) of body attitude if liftoff has not occurred."

"With a normal rotation rate, the all-engine liftoff attitude is 9-10 degrees"

Damage to aircraft

The lower fuselage exhibited damage consistent with a light, transient, contact between the underside of the aircraft and the runway. The damage comprised:-

- abrasion of the lower fuselage skins over an area bounded approximately by stations 908 and 1088 and stringers 26L and 25R, resulting in localised penetration through the skin at frame locations,
- secondary deformation of frame chords and attachment clips in these same areas,
- heavy contact ground damage to the drain mast, together with associated deformation and cracking of the underlying skin panel

- abrasion damage to the inboard side of the Aft Toilet Services panel on the right side.

Flight Recorders

Cockpit Voice Recorder

The CVR fitted was manufactured by Honeywell, employed a solid state recording medium and was of two hour duration. For the final 30 minutes this contained recordings on 4 independent channels, one for each of the two flight crew members, one for the PA, and one for the cockpit area microphone. For the total two hour duration there were also two separate channels recorded, the crew and PA channels combined into one, and the area microphone channel.

Flight Data Recorder

The DFDR was a Honeywell solid state recorder. The recorder was designed to accept data at a rate of up to 256 words/second. As the aircraft system only provided 64 words/second the total duration of the record was some 190 hours. A plot of selected parameters for the take-off run is at Figure 1 (*JPG 170kb*).

Take off history from recorded information

The aircraft started its take-off roll with left rudder and right Aileron applied to counteract the prevailing crosswind, and with forward stick applied. Throughout most of the take-off roll, comparison between the recorded groundspeed and airspeed indicated that the headwind component was varying between 11 kt and 17 kt, with a mean of about 15 kt. From 50 kt to the initiation of rotation, rudder had been held at between 2° and 21° to the left and over the later stages averaging about 6 degrees to the left. The control wheel had been held at between 19° and 25° right wing down demand, and the column about 1° to 2° forward. At an indicated CAS of 115 kt, some 23 seconds after the start of the take-off roll, the recorded CAS started to rise at an increased rate and after the next two seconds the indications were that the headwind component had increased to 25 kt. Two seconds later, about 27 seconds after the start of roll, the rotation was initiated at an airspeed of 141 kt.. Immediately following this the airspeed recordings showed a decrease from 141.5 kt to 137.5 kt over one second, whilst the groundspeed recordings showed a normal increase from 118 kt to 122 kt. This would be indicative of some wind shear at this instant, with the headwind component reducing from about 23 kt to 15 kt. The control column was pulled back to just over 6° and was then held between 5.8° and 6.8° for about 4 seconds. The aircraft started to pitch up and the peak pitch rate was between 5° and 6.5° per second. The aircraft started to lift off at about 10° of pitch and continued to pitch up continuously to just over 16° at a radio altitude reading of 9 feet. Between these two times it would appear that the tail struck the runway. After lift off the aircraft appeared to climb away normally.

Pitch rate at take off

The degree of control wheel used during the take off roll and rotation would have been sufficient to deploy the roll control spoilers on the right wing. It was thought that this could have affected the pitching moment and overall lift of the aircraft at this critical stage. However the Manufacturers examined the recorded data and came to the view that the small roll spoiler deflection would have had an insignificant effect on the pitching characteristics and overall lift coefficient of the aircraft.

The previous 18 take offs were examined and of these, 12 (66%) had derived pitch rates of less than $4^{\circ}/\text{sec}$, and 6 (33%) between 4 and $5^{\circ}/\text{sec}$. Two of the latter had momentary excursions to just over $5^{\circ}/\text{sec}$. In comparison the incident flight had a period of just over $5^{\circ}/\text{sec}$ with a possible momentary excursion to $6.5^{\circ}/\text{sec}$.