Report

Insufficient rotation during take-off, Boeing 737-400, EI-STW

Amsterdam Airport Schiphol, 19 December 2023

A Boeing 737-400 cargo aircraft of the freight operator ASL Airlines Ireland, with registration EI-STW, commenced the take-off from Intersection E4 of Runway 18L at Amsterdam Airport Schiphol (hereafter: Schiphol). It was conducting a flight for the cargo company DHL Aviation to Brussels Airport (EBBR), Belgium (hereafter: Brussels). During the take-off roll, the pilot flying experienced difficulties in rotating the aircraft to a lift-off attitude. Although the pilot applied more nose-up elevator input than normally required, the nose wheel of the aircraft remained on the ground until a further increase in airspeed. This allowed the aircraft to rotate and take off. Once airborne, elevator trim adjustments restored normal control. After the trim adjustment, the flight crew did not further experience any control problems during the remainder of the flight. After landing, the flight crew was informed that the aircraft had been incorrectly loaded. The operator notified the Dutch Safety Board the next day.

Factual

The Boeing 737-400 came from Dublin and arrived at Schiphol with five empty cargo containers and a ballast block which was positioned in the most aft cargo position on the cargo main deck. According to the supervisor of the cargo company, he discussed with the foreman of the ground handler that only the containers had to be offloaded. The ballast block[1] could stay where it was. According to the internal report of the ground handler, its foreman was told he had to offload five containers and had to move the ballast block to the position of the cargo door (position B in the load plan schematic.

During the stop at Schiphol – with 30 minutes turnaround time - the ground handler (in total six persons[2]) offloaded the containers and the 1,458 kg ballast block. There was no cargo (payload) for the outbound flight to Brussels and it was necessary that the ballast stayed on board on the rear position (position K) with a calculated CG position of 10,6 % MAC. The ground handler put the ballast block back in the aircraft on the cargo main deck at the position of the cargo door.

The loading supervisor had received the two scanners from the ground handlers and signed the papers in the pushback truck while waiting for instructions from the flight crew about the push back. Due to the rush (the flight was close to being delayed), he had been in the aircraft to handover the loading papers to the flight crew without verifying the correct loading. The captain signed the loading papers, the loading supervisor exited the aircraft and whilst standing on the main deck the first officer closed the cargo door. In view of the ground handler, the 'four eyes principle'[3] to crosscheck a correct loading of the aircraft had been undermined.

Loading of the aircraft

The cargo company was responsible for preparing the load plan, to calculate the center of gravity and to supervise the loading process. The actual aircraft loading and offloading was carried out by the subcontractor Menzies Aviation. That was the ground handler, which was responsible to comply with the load plan. The freight operator was the third party and ultimately responsible for the safe execution of the flight. Information from the cargo company revealed that time pressure was common in order to realize that flights depart on time. In addition, it says that time pressure should not result into cutting corners allowing flight safety incidents to happen. Since a few months, as directed by the cargo company, the

1 Ballast block: material in an aircraft deliberately placed to influence its center of gravity (CG) to realise that the CG is not beyond the forward or aft limits.

2 One foreman and five other employees with a mix of experienced and unexperienced persons.

3 Four eyes principle: as indicated in the manual Local Operating Procedure No.5 loading ULD, in addition to its own ground handler this should always include one airline representative, a certified load master or load controller.

▲ *Archive photo of the aircraft involved (source: Gábor Szabados).*

way of loading an aircraft had changed. Instead of using a load plan on paper, ground staff of the ground handler now used two handheld computers – connected to a main system - to scan the cargo containers.[4]

The loading process starts with the foreman of the ground handler scanning each container with the handheld computer on the ground before it is moved to the aircraft for loading. This scan updates the system to show a "blue" status for the container. During loading, the handheld computers receive the planned position of the cargo containers from the load plan. Once each cargo container is on its designated position in the aircraft, the ground handler in the aircraft manually enters the mass and position of the container in the second handheld computer. This action updates the system to show a "green" status for the container. If required for mass and balance purposes, a ballast blocks may be loaded and scanned on the same way as cargo containers.

4 Before the introduction of the scanners, some ground handling employees of the team had the load plan on paper. Since scanners were put into use, two employees have a scanner.

The Ground Operations Manual[5] of the freight operator prescribed that 'no aircraft shall depart unless a load sheet has been produced and signed by the aircraft captain (…). For any operation, based upon his load plan the supervisor of the cargo company will normally complete the load sheet. The handling agent will sign a statement on the load plan confirming that the aircraft is loaded in accordance with the plan and that the load is secure.' At the end of this process, as explained by the employees of the ground handler, there is time pressure to have the paperwork signed.

The flight and take-off performance

The maximum take-off mass (MTOM) for EI-STW was 56,1 tons. The calculated TOM for the short flight to Brussels was 39,7 tons, which included 5,2 tons total fuel and the ballast block. The calculated CG position required the trim to be set at 4.42 units.

For a take-off from Intersection E4 of Runway 18L at Schiphol, the declared distances[6] were 2,582 meters (TORA) and 2,642 meters (TODA). The calculated decision speed V_1 was 116 knots and the rotation speed Vr was 118 knots with the engines set to the minimum allowable thrust[7] for take-off.

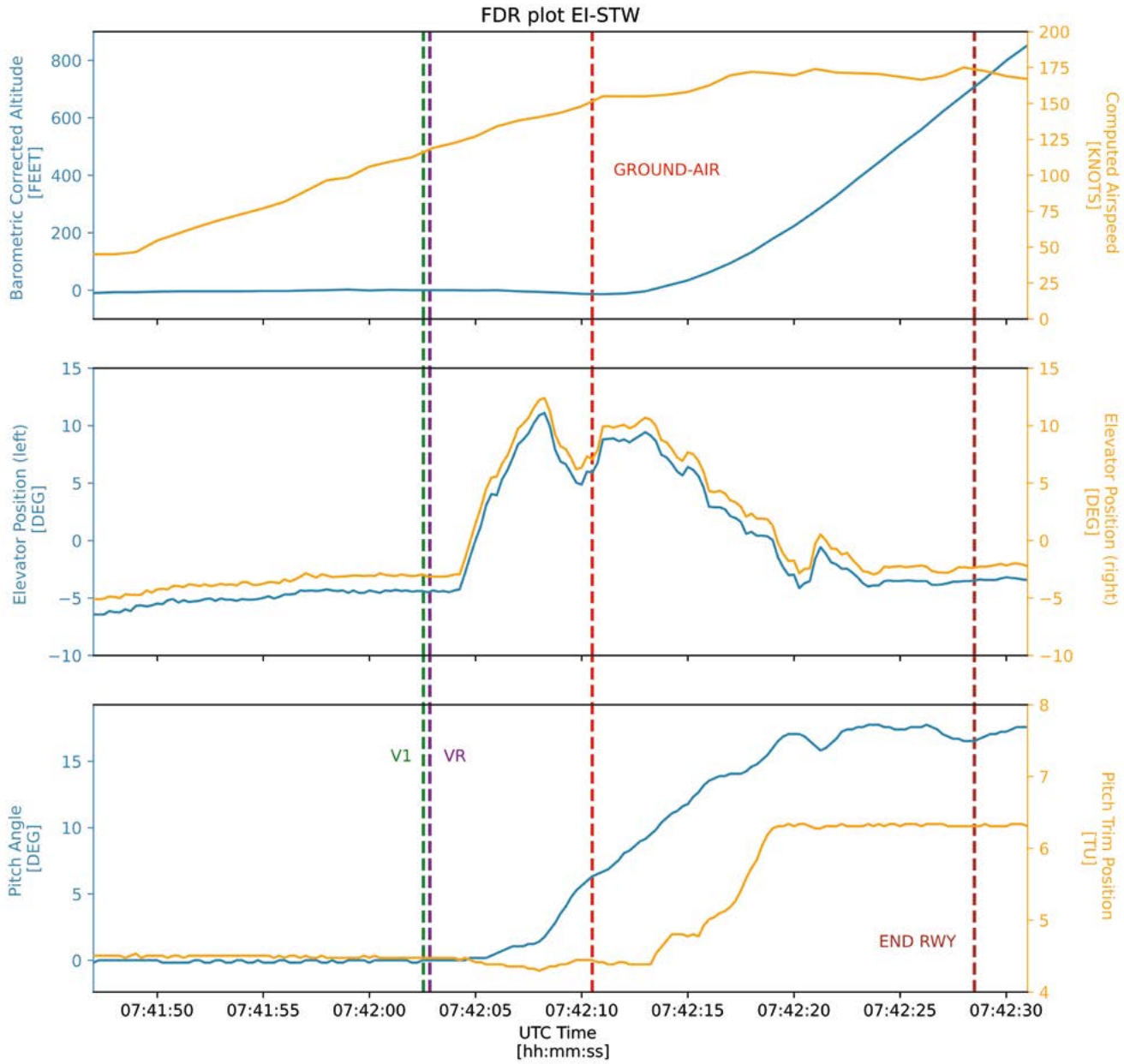
The take-off roll proceeded normally until the calculated rotation speed was reached. When the first officer, acting as pilot flying, applied almost full nose up elevator input, the aircraft did not rotate as expected. The aircraft further accelerated and, when applying full nose up elevator, rotation started at 134 knots. The aircraft became airborne at 150 knots and it passed the reciprocal threshold (elevation -11 feet) at 707 feet above mean sea level. The first-officer trimmed the aircraft where after the flight crew did not experience further pitch control problems. Flight data showed that the autopilot was engaged during climb at 1,787 ft above mean sea level

Remainder of the flight

During the cruise phase, the flight crew discussed what could have caused the difficulties they encountered during rotation of the aircraft. They reviewed the take-off performance calculation and the load sheet and agreed that everything was calculated correctly.

In the meantime, the ground handler at Schiphol became aware of the incorrectly positioned ballast block and informed the cargo company. By the time this was communicated, the aircraft was on final approach to Brussels. The flight crew was notified of the incorrect loading after landing.

5 Ground operations manual (GOM), B737-400 SF, All Audiences, Paragraph 9.1.1.
6 Take-off Run Available (TORA) and Take-off Distance Available (TODA), as published in the Aeronautical Information Publication (AIP) of the Netherlands.
7 Runway 18L, Intersection E4, take-off gross weight 39,664 kg, flaps 5 degrees, assumed temperature for engine thrust 62 degrees Celsius, outside air temperature 9 degrees Celsius, QNH 1018 hPa.



▲ *Flight data the take-off (source: Flight Data Recorder).*

Analysis

The loading process

Neither the supervisor of the cargo company nor the staff of the ground handler had checked whether the aircraft had been loaded correctly, but nevertheless signed the loading papers. Airline procedures required only the captain to sign the load sheet, but not the flight crew to check the correct loading of the aircraft. The first officer - standing next to the ballast block when closing the cargo door – did not realise that it was on the wrong position. Consequently, the ballast block remained at the cargo door position causing the CG to be significantly further forward than assumed by the flight crew and with effect on the pitch controllability.

The flight crew had set the trim in accordance with the load sheet (4.42 units trim position corresponding a CG position of 10,6 % MAC). However, the actual CG position was -8,9 % MAC, which was significantly beyond the 7% forward limit. This difference in CG position represented an equivalent of 7 trim units for take-off and explaining the elevator control difficulty during rotation. With a CG position of -9 % during landing, the aircraft remained controllable at that time.

The supervisor believed that he had communicated with the foreman that the ballast block could stay on its position. However, the ground handlers nevertheless offloaded the ballast block together with the five containers as they believed this had been instructed. This misunderstanding could not be explained. As only two scanners were available for loading, not every ground handler (six in total) may have known the loading plan and miscommunication cannot be ruled out.

The take-off roll

The take-off was normal until the rotation speed was reached. The first officer applied almost full nose up elevator deflection for rotating the aircraft. Despite applying full nose up elevator, the aircraft did not rotate to a lift off attitude. Only when the airspeed increased from the calculated Vr of 118 knots up to a value of 134 knots, the first officer was able to rotate the aircraft into the air. With an airspeed of 150 knots the aircraft lifted-off and he used the elevator trim to reduce the required control force for elevator up. Once in trim, the control of the aircraft was normal.

For the take-off performance calculation, the flight crew used the maximum allowable thrust reduction as the aircraft was almost empty and with a fuel load for the short flight to Brussels. Therefore, an intersection take-off was possible, which resulted in a reduced available runway length. Even with this reduced length, the aircraft became airborne before the midway point of the available runway and crossed the reciprocal runway threshold at 718 feet[8, 9].

8 The consequences of the performance of an engine failure on V_1 or immediately after V_1 have not been analysed in this report.
9 707 feet above mean sea level plus 11 feet.

Visual presentation of the take-off performance. The 'ground-air' point indicates the position where the aircraft became airborne (source: Flight Data Recorder and Google Earth).

Conclusion

The incorrect loading of the ballast block happened within the context of time pressure, where papers were signed without actually checking the correct position of the ballast block. This resulted in center of gravity being significantly further forwards than the flight crew assumed and created a mismatch of the stabilizer trim position.

Elevator deflection during rotation at the calculated Vr was ineffective because the stabilizer was seven units out of the required trim position. This delayed rotation and lift off and demanded more runway length. Despite the fact that the center of gravity was significantly out of the flight envelope, with the adjusted stabilizer trim the aircraft was controllable during the remainder of the flight.

When using intersection E4, the available runway length (TORA) and take-off distance (TODA) were adequate for the actual required runway length and threshold obstacle clearance.

Corrective actions

With immediate effect the cargo company prescribed to its employees to send all communications and all plans for offloading and loading to the ground handler by emails. This is to prevent the possibility of miscommunication.

All personnel of the ground handling company were made aware of the incident. The cargo company and ground handler reviewed internal procedures.

The airline issued a warning to all flight crew members emphasizing that the final responsibility for correct aircraft loading rests with the captain. Flight crews are now required to verify ballast positioning when operating with empty or lightly loaded aircraft.

The Dutch Safety Board issued no recommendations to the involved parties, given the measures already taken by the parties involved.

Classification: Serious incident
Reference: 2023241