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## Tailstrike on takeoff, Serious incident occurring on November 29, 2002 at Dortmund Airport involving a Boeing 737-800

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**Micro-summary: Tail scrape on takeoff involving a Boeing 737-800.**

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**Event Date: 2002-11-29 at 0940 UTC**

**Investigative Body: Federal Bureau of Aircraft Accidents Investigation (BFU), Germany**

**Investigative Body's Web Site: <http://www.bfu-web.de/>**

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# Investigation Report

EX007-0/02  
April 2004

## Identification

Kind of occurrence: Serious incident  
Date: 29 November 2002  
Location: Dortmund Airport  
Aircraft: transport category airplane  
Manufacturer/type: Boeing Company / Boeing 737-800  
Injuries to persons: no injuries  
Damage to aircraft: airplane slightly damaged  
Other damage: none  
Source of information: investigation by the BFU

## Factual information

### Events and history of the flight

The BFU was informed on 29 November 2002 at 09:40 hrs<sup>1</sup> by the air traffic surveillance of Dortmund Airport that the tail of a Boeing 737-800 had touched the runway during the take-off and therefore the flight crew had aborted the take-off.

The crew had to conduct a charter flight from Dortmund (EDLW) to Izmir (LTBJ) and afterwards to Ankara (LTAC). Six crew members and 112 passengers were aboard the airplane.

Having taxied onto runway 24 via taxiway D, the flight crew received at 08:37 hrs the take-off clearance from the responsible Air Traffic Control unit (Tower), indicated surface wind was 180° and 6 kt.

When the airplane had started the take-off run and prior to reaching full engine thrust the nose gear lifted off and the airplane tail touched the runway. The engine thrust was reduced immediately and the nose gear touched down again. The pilot flying (PF) immediately aborted the take-off. The airplane was taxied back to the terminal.

### Personnel information

The flight crew members were holding the required licences (ATPL) and ratings for the Boeing 737-800. The medical certificates (Class I) for both pilots had been submitted and were valid.

The pilot-in-command (PIC) had a total flying experience of 10 360 flight hours, of which 1 018 hours on the Boeing 737-800. The co-pilot (FO) had a flight experience of 3 930 hours, 423 hours of which on the Boeing 737-800.

The incident flight was the second flight conducted by the flight crew on this day.

The ramp agent of the dispatch company at Dortmund had participated in training courses for "Quality Management", "Passage Training" and "Weight and Balance B737/757" and according to the statement of the dispatch company had obtained the necessary qualification. The last participation in an internal training course was from 20 to 22 February 2002.

### Aircraft information

The airplane was a Boeing 737-86N (737-800) with the serial number 32735. It was certificated on 20 April 2002 in Turkey and up to the incident, 2 387 flight hours and 836 landings had been recorded in the airplane's flight log. The transport category airplane was operated by the air carrier for the international trans-

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<sup>1</sup> Unless otherwise specified all times are indicated in UTC.

portation of passengers in scheduled and non-scheduled air services. The Certificate of Airworthiness and the Certificate of Registration were both valid.

During the flights immediately prior to the incident no technical findings had been entered into the Airplane Technical Log.

#### Meteorological information

According to the meteorological aviation routine report (METAR) of 08:20 hrs, the surface wind was blowing from 180° with 6 kt, the surface visibility was 8 km, the cloud bases were 3 400 ft (1/8 to 2/8) and 4 700 ft (5/8 to 7/8), the air temperature was +8°C, the dew point +7°C and the QNH was 1012 hPa.

#### Communications

The radio communications conducted between the crew and the tower on the frequency 134.175 MHz is available to the BFU as a tape transcript. The radio communications did not contain any information relevant to the incident.

#### Aerodrome information

The airport is located 10 km east of the city of Dortmund and has an elevation of 424 ft. It has a paved runway of 2 000 m length and 45 m width with a true bearing of 061°/241°.

#### Flight Recorders

The digital flight data recorder (DFDR) and the cockpit voice recorder had not been evaluated.

#### Accident site and findings on the airplane

##### 1. Evaluation of traces on runway 24.

On the runway, two abrasive marks immediately following each other were found. The first trace started approximately 153 m from the beginning of the runway, was running into the direction of 241° and had a length of 3 m. Following the first mark, there was a wider trace of a length of 6 m. Both traces were slightly to the right of the runway centre line.

##### 2. Findings on the Boeing 737-800

Some material of the tail skid fitted to the lower surface of the fuselage tail had been cut away. Some material of the fuselage shells below the rear cargo compartment had been cut away as well and parts of them had been heavily deformed. In some areas there were holes. Due to the damage the pressurized cabin had been affected as well. The frames themselves within the rear cargo compartment had not been damaged. However, some rivets on the clips (connections be-

tween the skin and the frames) had been torn off. Some clips had been deformed.

##### 3. Loading and mass & balance of the airplane

Following the return to the terminal the loading and the mass and balance of the airplane were examined under the direction of the BFU Field Investigator. The examination revealed that the loading, the masses and the centre of gravity position as indicated in the Load & Trim-Sheet were not correct.

##### – Checking of the fuel quantity aboard the airplane

The airplane had landed with a residual fuel quantity of 4 280 kg. For the flight to Izmir, a BLOCK-FUEL quantity of 10 580 kg had been planned. At Dortmund the airplane was refuelled with 6 650 kg. Together with the residual fuel, this resulted in a total fuel quantity of 10 930 kg. Pursuant to the fuel indication checked aboard the aircraft, the quantities were: Left tank 3 920 kg, right tank 3 940 kg, centre tank 3 160 kg, total fuel quantity indicated 11 020 kg. In the Load & Trim-Sheet a fuel quantity of 10 850 kg was entered.

##### – Check of the loading conducted at Dortmund and the associated masses.

In the standard loading of the airplane a spare wheel with a calculated mass of 150 kg to be carried in the front cargo compartment is included. The check revealed that the wheel had not been carried aboard. Hence the dry operating mass (DOW) of the Boeing 737-800 of 42 498 kg would have had to be reduced by 150 kg.

The correct value would have been 42 348 kg.

Thus the centre of gravity (DOI) had to be corrected as well. For a DOI of 39.92 for the standard variant an index of 1.9 would have had to be added due to the missing wheel. In the Load & Trim-Sheet a value of 41.82 would have had to be used.

The ramp agent, however, had received the incorrect information (DOW 42 498 kg, DOI 39.92) from the flight crew.

The catering for the return flight, which had been transported in the front cargo compartment from Istanbul, was distributed to the galleys as follows: Front galley 196 kg, rear galley 406 kg.

Pursuant to the GOM (Ground Operations Manual) of the aircraft operator, dated 01 August 2001, number 2.5.11, B737-800 Pantry Weight & Index, the standard distribution is 250 kg for the front galley and 300 kg for the rear galley.

With the actual distribution the following corrections to the DOI would have been necessary:  
 Front galley 250 kg – 196 kg = 54 kg  
 $54 \text{ kg} \times (-0.015671) = -0.846$   
 rear galley 406 kg – 300 kg = 106 kg  
 $106 \text{ kg} \times 0.015757 = 1.670$   
 The DOI would have had to be corrected in the Load & Trim-Sheet by a further value of  $1.670 - (-0.846) = 2.516$ .

The centre of gravity position thus was  $39.92 + 1.9$  (missing spare wheel)  $+ 2.516$  (correction for the catering) = 44.336

Aboard the airplane were the flight crew with two pilots, the cabin crew with four flight attendants as well as 110 adults, 2 children and 1 infant.  
 The distribution of the passengers in the cabin was as follows: Compartment A none, Compartment B 22, Compartment C 43, Compartment D 47.  
 The standard masses used by the operator were 70 kg for an adult and 30 kg for a child.  
 This would have resulted in a mass of  $110 \times 70 \text{ kg} + 2 \times 30 \text{ kg} = 7\,760 \text{ kg}$ .  
 The ramp agent had entered 7 960 kg in the Load & Trim-Sheet, i.e. 200 kg too much.

The "Passage" department of Dortmund Airport had taken over the check in of the passengers and the weighing of the baggage. Pursuant to the instruction of the dispatch company, the airport staff members were to assign the seats to the passengers from the rear to the front. This instruction was observed by the personnel. They assigned the seats from the rear to the front of the cabin.  
 In the Operating Procedures Manual of the operator, number 8.1.8.5, Seating Policy, dated 01 January 1997, the distribution of the passengers in the cabin was not prescribed.

The total mass of the passengers' baggage transmitted by the "Passage" department to the ramp agent was  
 2 930 kg – 1 872 kg for Izmir and 1 058 kg for Ankara.

The distribution of the baggage to the front and the rear cargo compartments was accomplished by the baggage loading staff. They informed the ramp agent that they had stowed the heavy baggage in the front and the light baggage in the rear compartment. The ramp agent inspected the baggage and estimated the masses as follows:

For Izmir 1 172 kg in the front and 700 kg in the rear cargo compartment. For Ankara 1 058 kg only in the rear cargo compartment. These values were also entered into the Load & Trim-Sheet.

Following the incident the baggage was weighed once again. The results of the weighing were as follows: In the front cargo compartment 692 kg (680 kg baggage and 12 kg waste). In the rear cargo compartment 2 092 kg. The total mass thus was 2 784 kg. The discrepancy between the actual value and the value transmitted by the "Passage" department (2 930 kg) could not be clarified anymore.  
 Thus the baggage loaded into the front cargo compartment was  $1\,172 \text{ kg} - 692 \text{ kg} = 480 \text{ kg}$  less and the baggage loaded into the rear cargo compartment was  $2\,092 \text{ kg} - 1\,758 \text{ kg} = 334 \text{ kg}$  more.

While preparing the Load & Trim-Sheet with the values transmitted by the crew, the ramp agent realized that the centre of gravity position would be outside the rear operational limit and therefore planned to move 5 passengers each from the compartments D and C into the compartment A.  
 The ramp agent incorporated this move into the Load & Trim-Sheet in the 'INDEX' section, i.e. 10 passengers were entered for the compartment A. With the correction performed the centre of gravity position thus was within the allowable range.

In the column "PASSENGERS ON BOARD" the numbers of passengers entered for the compartments C and D were incorrect. The numbers 33 and 37 had been entered. The correct numbers would have been 38 and 42. But in the 'INDEX' section, which is important to the determination of the centre of gravity position the correct numbers had been entered.

When the ramp agent handed the Load & Trim-Sheet over to the PIC, she informed him that 10 passengers had to be moved. The PIC confirmed to the BFU Field Investigator that he had received this information. The PIC signed the Load & Trim-Sheet.

The ramp agent did not inform the cabin crew that passengers had to be moved to compartment A. The 10 passengers were not moved.

From the Load & Trim-Sheet enclosed the actual masses, the corrected DOI, and the actual passenger distribution in the cabin are to be seen.

## Analysis

According to the documentation submitted, the airplane had properly been certificated for air traffic. The investigation has not revealed any findings indicating technical defects. No findings had been entered into the airplane's technical log.

The weather had no influence on the course of the incident.

The flight crew and the cabin crew were holding the necessary licences and ratings. They were valid at the time of the incident. The flight crew members held medical certificates and their medical fitness was documented.

The ramp agent had participated in the training for "Weight and Balance B737/757" and had obtained the necessary qualification.

The DOW (42 498 kg) and DOI (39.92) values the PIC had transmitted to the ramp agent were incorrect, as the spare wheel was not carried aboard. The actual values were DOW = 42 348 kg and DOI = 41.82.

The mass of the catering carried from Istanbul was 602 kg. 196 kg of the catering were stowed in the front and 406 kg in the rear galley. Pursuant to the GOM for this flight 250 kg are planned to be stowed in the front and 300 kg in the rear galley. The correction of the DOI by 2.516 which thus would have had become necessary was not made.

In accordance with an instruction issued by the dispatch company, the "Passage" department had assigned the passenger seats from the rear to the front of the cabin. However, there was no such instruction by the operator concerned.

Due to the rear centre of gravity position to be expected in view of the Load & Trim-Sheet, the ramp agent informed the PIC that 10 passengers had to be moved from the rear to the front. This move was documented in the Load & Trim-Sheet but in fact the passengers remained on the seats they had been assigned by the passage department. There was no instruction to the cabin crew by the ramp agent.

The masses of the baggage loaded into the individual cargo compartments had been estimated by the ramp agent. With a reweighing it was found that the baggage in the front cargo compartment was 480 kg less and in the rear cargo compartment 334 kg more.

The investigation has been conducted in compliance with the Law Relating to the Investigation into Accidents and Incidents Associated with the Operation of Civil Aircraft (Flugunfall-Untersuchungs-Gesetz - FIUUG) dated 26 August 1998. According to this Law, the sole objective of the investigation shall be the prevention of future accidents and incidents. It is not the purpose of this activity to apportion blame or liability or to establish claims.

The entries in the Load & Trim-Sheet were not correct.

The passenger mass of 7 960 kg entered into the Load & Trim-Sheet was incorrect. The correct value would have been 7 760 kg.

With the move of the passenger into the compartment A, the centre of gravity position would have been within the allowable range even with the deviations found (no spare wheel, no correction for the catering, deviating masses in the front and the rear cargo compartments and incorrect entry for the passenger mass).

With the move of the passengers not accomplished, the centre of gravity position during the take-off of the Boeing 737-800 was far beyond the allowable rear range.

The values assumed for holiday charter flights according to table 1 of JAR-OPS 1.620 "mass values for passengers and baggage" are 76 kg for adults and 35 kg for children. The operator received an approval from the Turkish Directorate General of Civil Aviation (DGCA) in accordance with JAR-OPS 1.620 (g) to deviate from JAR-OPS 1.620 (70 kg for adults and 30 kg for children).

## Conclusions

The incident is due to the fact that the airplane was operated with the centre of gravity position outside the operational limit.

Investigator-in-charge	Eberhard Krupper
Assisted by:	Peter Baus BFU Field Investigator

## Encl.

Load & Trim-Sheet of the incident flight with the actual entries

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LOAD AND TRIM SHEET - FLAP SETTING  
B 737-800

AIRLINES

Prefix: \_\_\_\_\_ Address: \_\_\_\_\_  
 Originator: \_\_\_\_\_ Recharge / Date / Time: \_\_\_\_\_ Initials: \_\_\_\_\_  
 Flight: \_\_\_\_\_ Date: \_\_\_\_\_ Registration: \_\_\_\_\_ Version: \_\_\_\_\_ Crew: \_\_\_\_\_

ALL WEIGHTS IN KILOGRAMS

DRY OPERATING WEIGHT		MAXIMUM WEIGHTS FOR	ZERO FUEL	TAKE-OFF	LANDING
Takeoff fuel	+			Trip Fuel	
OPERATING WEIGHT	=	Allowed Weight for Take-off Lowest of a b c			
Allowed Traffic Load	=				
Total Traffic Load	=				
Underload before LMC	=				

DEST	No. of Passengers				TOTAL	Distribution Weight			Remarks
	M	F	C	I		FWD HOLD	AFT HOLD	0	
					1	4		Pax	
								C M/Y	

LAST MINUTE CHANGES				
Desl.	Specification	Cpt	Plus	Minus

TOTAL TRAFFIC LOAD	=	
Dry Operating Weight	+	
ZERO FUEL WEIGHT	=	
Take Off Fuel	+	
TAKE OFF WEIGHT	=	
Trip Fuel	-	
LANDING WEIGHT	=	

BALANCE CONDITIONS		FROM	PREPARED
TAKEOFF	% MAC		
ZERO FUEL	% MAC		
FLAPS	UNITS	TO	APPROVED
STAB TRIM	UNITS		

