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25 August, 2023
66-CB-H200-ASI-19304

Sathya Silva
Investigator In Charge
National Transportation Safety Board
490 L' Enfant Plaza East, SW
Washington, DC 20594

Subject: Boeing Submission for the RED Air MD-82 HI1064 Landing Gear Collapse in Miami, Florida, 21 June 2022

References: (a) E-mail, 28 July 2023, NTSB to Boeing, RED Air Docket Opening Today

Dear Dr. Silva:

As requested in the reference e-mail regarding the technical review, please find the attached Boeing submission on the subject accident. Per your request we are sending this electronic version to your attention for distribution within the NTSB.

We would like to thank the NTSB for giving us the opportunity to make this submission. If you have any questions, please don't hesitate to contact us.

Best regards,

[redacted]

Robert J. McIntosh
Director, Product Safety

Enclosure: Boeing Submission to the NTSB for the subject accident

Submission to the

National Transportation Safety Board

for the

Red Air MD-82 HI1064 Landing Gear Collapse and Runway Excursion at Miami International Airport, Florida 21 June, 2022

The Boeing Company
25 August 2023

INTRODUCTION

On June 21, 2022, at approximately 17:38 Eastern Standard Time, a McDonnel Douglas MD80-82 HI1064, operated by Red Air, experienced a left main landing gear failure shortly after landing on runway 09 at Miami International Airport, Miami, Florida. The aircraft departed runway 09 and contacted a glideslope antenna and airport equipment building before coming to rest in a grassy area between runways 09 and 30. A post-crash fire occurred and was extinguished by the Miami-Date fire rescue. The aircraft was evacuated and 4 passengers received minor injuries.

Submission Abstract

- The Boeing Company, as the airplane's manufacturer, is an invited party to the investigation and provides technical and operational assistance to the National Transportation Safety Board (NTSB) in their investigation.
- The conclusions presented in this submission are based on factual information received from the NTSB, Boeing expertise, the use of analytical tools, and a methodical investigation process.
- Landing gear shimmy is torsional vibration of the landing gear. A shimmy is more likely to develop in the landing gear with higher speed landings, lighter gross weight, and higher initial braking.
- A hydraulic shimmy damper is installed on each main landing gear and is designed to prevent excessive vibration or shimmy buildup in the main landing gear. The damper is separate from the airplane hydraulic system, and requires independent servicing with fluid. It will not function properly to dampen a shimmy condition if not properly serviced hydraulic fluid
- Shortly after touchdown, a shimmy developed in the left main gear. The shimmy grew in magnitude until the left main landing gear failed and collapsed
- The left main gear shimmy damper service port cap was found to be missing from the shimmy damper. During lab testing the shimmy damper service port check valve was found to leak fluid at all pressures tested. Examination of the shimmy damper found no other anomalies which likely contributed to shimmy event.
- Because the shimmy damper reservoir became detached from the shimmy damper housing during the accident sequence, it was not possible to determine if there was hydraulic fluid in the shimmy damper at the time of landing.
- The accident likely resulted from an improperly serviced or empty left main landing gear shimmy damper that could not arrest a left main landing gear shimmy condition, which developed shortly after a soft touchdown and immediate brake application.

BOEING ASSISTANCE WITH THIS INVESTIGATION

The National Transportation Safety Board (NTSB) is conducting the investigation into this Red Air MD-82 accident. Assisting the NTSB in their investigation are the Federal Aviation Administration (FAA), the Comisión Investigadora de Accidentes de Aviación (CIAA) of the Dominican Republic, Boeing, and other designated parties.

As the manufacturer of the MD-82 airplane, Boeing's specific role in this investigation has been to provide technical information regarding the airplane design, manufacture and operation to assist the NTSB.

Furthermore, the NTSB requested that all parties submit proposed findings to be drawn from the factual information established during the course of the investigation. Boeing has responded to the NTSB request with this document, which:

- Provides an assessment of the factual information and other pertinent data.
- Identifies knowledge gained from the investigation.
- Identifies conclusions and recommendations supported by the knowledge gained from the investigation.

BOEING ASSESSMENT

The Boeing assessment of the accident is based upon the facts as documented in the NTSB's factual reports. These reports are observations of the airplane and accident site, post-accident examination of airplane systems and components, flight data recorder (FDR) data, cockpit voice recorder (CVR) data, and flight crew interviews.

SEQUENCE OF EVENTS

On June 21, RED Air flight 203 departed Santa Domingo, Dominican Republic on a 14 CFR Part 129 scheduled international passenger flight to Miami International Airport (MIA), Miami Florida. There were 130 passengers on board the airplane and the crew consisted of two pilots, two flight mechanics, four flight attendants, and two training/observing flight attendants. There were 140 total occupants on board.

The flight departed Las Americas International Airport (SDQ), Santo Domingo, Dominican Republic, at 1435 Eastern and arrived at MIA at 1738. Prior to the arrival at MIA the flight was cleared for the ILS approach to runway 09. The approach was described as 'normal' by the crew.[1] The touchdown was smooth, on the right main gear and a little to the right of the centerline. A few seconds after touchdown, the thrust reversers were deployed. Then there was a vibration on the left side of the airplane, "explosion" (as recalled by the First Officer), and a subsequent sinking of the airplane to the left. The thrust reversers were stowed soon after the vibration began.[2]

The aircraft departed the runway to the left, and contacted a glideslope antenna and airport equipment building. The aircraft came to a stop, and a post-crash fire developed on the right side wing where the wing had contacted the glideslope antenna.

An evacuation of the cabin was initiated using the only the left side exits (due to the fire on the right wing). All crew and passengers successfully evacuated the aircraft. There were four reported minor injuries. Miami-Dade Fire Rescue responded to the accident and arrived at the site as the evacuation was in progress. The fire on the right wing was extinguished by one of the fire department foam trucks.

Weather

At 1753 EDT, the MIA Automated Surface Observing Systems (ASOS) reported a wind from 050° at 9 knots gusting to 16 knots, visibility of 10 statute miles or greater, a few clouds at 3,000 feet above ground level (AGL), a few clouds at 4,500 feet AGL, broken ceiling at 25,000 feet AGL, temperature of 30° Celsius (C), dew point temperature of 16°C, and altimeter setting of 30.08 inches of mercury.[3] Weather was not considered a significant factor in this accident.

Flight Data Recorder Information

The aircraft was equipped with a Fairchild Model F1000 Flight Data Recorder (FDR). The recorder was in good condition and the data were extracted normally from the recorder. The FDR contained approximately 48 hours of data. The event flight was the last flight of the recording, and its duration was approximately 2 hours and 7 minutes.[4]

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[1] NTSB Operational Factors/Human Performance Group Chairman's Factual Report dated June 15, 2023, page 5

[2] NTSB Operational Factors/Human Performance Group Chairman's Factual Report dated June 15, 2023, page 6

[3] NTSB Performance Study dated July 7, 2023, page 4

[4] NTSB Flight Data Recorder Specialist's Factual Report dated March 1, 2023, pages 2-3

Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. Correlation of the FDR data from SRN was not possible as the recorder did not record the time parameter in UTC. Therefore no time correlation was conducted and the time history plots in the NTSB Flight Data Recorder report and used to create the timeline below are left in raw SRN.

The FDR data shows that the aircraft touchdown on the runway was smooth, with little vertical acceleration at the time of touchdown. The highest vertical acceleration recorded during the touchdown was 1.16g. The touchdown speed was approximately 140 knots airspeed. The flap setting was 28 degrees.

The air/ground switch first recorded ground mode at SRN 173361. The air/ground switch then changed to air at SRN 173362. At SRN 173363 the air/ground switch returned to ground, and left brake pressure increased from 0 to 166 psi while right brake pressure remained 0. Oscillations in vertical acceleration begin at this point, indicating the shimmy has begun. By SNR 173368 left brake pressure increased from 166 psi to 2381 psi, while right brake pressure remained at 0. At SNR 173370 the Master Warning alert was activated and the air/ground switch changed to air. The last valid data point before a 16 second lapse of recording was at SRN 173373. At SRN 173390 data capture resumes and the air/ground switch again shows ground. At SRN 173402 the recording ended.[5] It is suspected the right brake pressure parameter data is invalid.

Flight Crew Interviews

As described by the flight crew, the flight to Miami and approach to landing were normal with no significant anomalies. The autopilot was disconnected at a few hundred feet above ground level and the landing was hand-flown by the First Officer.[6]

The First Officer (FO) recalled touching down smoothly on the right main then the left main slightly right of the centerline which he corrected after touching down. Soon after the crew felt a vibration on the left side of the airplane. The vibration increased and the airplane settled to the left. The crew tried to maintain centerline, but the airplane veered to the left and eventually departed the paved surface striking the glide slope equipment building. After contact with the runway 30 glide slope equipment shed and antenna, the nose landing gear and the right main landing gear collapsed. A post-crash fire began on the right wing after a breach of the wings fuel tank at the impact point of the glide slope antenna. The crew told the passengers to remain seated and began the engine shutdown checklist. The lead flight attendant alerted the crew to smoke in the cabin and the captain commanded a passenger evacuation and the crew conducted the evacuation checklist. Prior to evacuating the airplane, the captain walked to the back of the cabin to ensure all passengers and crew were off the airplane. He returned to the front of the cabin and evacuated following the lead flight attendant and FO through the L1 door.[7]

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[5] NTSB Flight Data Recorder Specialist's Factual Report dated March 1, 2023, pages 4-5

[6] NTSB Operational Factors/Human Performance Group Chairman's Factual Report dated June 15, 2023, pages 5-7

[7] NTSB Operational Factors/Human Performance Group Chairman's Factual Report dated June 15, 2023, page 7

AIRPLANE SYSTEMS

Landing Gear System Description

The airplane is equipped with a fully retractable tricycle landing gear consisting of nose gear and main gear assemblies. The nose gear assembly is steerable, has dual wheels, and is mounted in a wheel well in the forward lower section of the nose of the airplane. The main gear assembly consists of a right and a left main gear assembly which are not interchange-able. The main gear assemblies are strut mounted to a support fitting attached to the wing rear spar in the root area of each wing. The main gear assemblies retract into wheel wells on each side of the lower fuselage and are enclosed by doors faired to the fuselage contour.

Each main gear wheel is fitted with a hydraulic power disc brake. The brakes are manually controlled and metered by the brake control valves, which are operated by a cable system connected to the brake pedals. An electrically controlled anti-skid system provides a locked-wheel protection feature and affords a maximum efficiency to the brake system. The antiskid system dual servo valves meter applied pressure to the brakes as required to prevent skidding.

Shimmy Damper System Description

Wheel shimmy or landing gear shimmy is an unwanted vibration of the landing gear. Pilots experience the shimmy as a shudder or low-frequency vibration. Main gear shimmy is a torsional vibration mode of the landing gear where the inner cylinder rotates (oscillates) relative to the outer cylinder. Testing performed during the development of the MD-80 had shown that a shimmy is more likely to develop in the landing gear with higher speed landings, lighter gross weight, and higher initial braking.

To prevent excessive vibration or shimmy buildup in the main landing gear during high-speed taxi and under heavy braking, the MD-80 (like most large airplanes with single-axle main landing gears) is equipped with a shimmy damper on both main landing gear. The shimmy damper is connected between the upper and lower torque links and allows a small, but highly damped, motion to occur around the torsional axis of the gear. Due to the geometry of the torque links, the damper effectiveness is maximized when the landing gear strut is compressed. Limited dampening capability is available when the landing gear strut is fully extended.

The shimmy damper is a self-contained hydraulic unit consisting of a housing and hydraulic reservoir. The damper is an independently serviced, closed system that is separate from the airplane main hydraulic systems.

The damper housing contains a piston, which separates two chambers that must be filled with hydraulic fluid per its servicing instructions for proper operation. As the piston moves back and forth between the chambers, the motion is dampened by restricting hydraulic fluid flow between the chambers through orifices in the piston. The damper also employs a Belleville spring arrangement, to keep the piston centered in the damper.

A hydraulic fluid reservoir is attached to the damper housing. The reservoir contains a spring which pressurizes the hydraulic fluid in the reservoir and damper to 40 to 55 PSI. There is a bleed port at the top of the reservoir. A check valve and cap is located at the bottom of the damper housing. The damper may be serviced by adding fluid using either the bleed port at the top or the check valve on the bottom, and air is removed from the damper via the bleed port.

Markings on the reservoir indicate the hydraulic fluid level in the reservoir and a label on the side of the reservoir provides servicing instructions.

The shimmy damper check valve allows fluid into the shimmy damper when it is being serviced, and then retains that fluid in the shimmy damper. The check valve is the primary mechanism to retain hydraulic fluid within the damper, while the cap acts as a secondary method of fluid retention. The cap is secured to the shimmy damper housing with lockwire.

In addition to the servicing instructions for the shimmy damper provided on the damper label, servicing instructions are provided in the Aircraft Maintenance Manual. Shimmy damper reservoir fluid levels are to be checked during scheduled service checks. They are also listed to be inspected as part of the flight crew exterior inspection procedure in the flight crew operations manual.

Tire Marks on Runway

From video evidence, the airplane touched down on runway 09 with approximately 8900 feet remaining. Tire deposits on the runway, which started about 1300 ft later, showed evidence of left main gear shimmy. The amplitude of the shimmy steadily increased until the left main landing gear collapsed under the airplane about 675 feet further down the runway. The airplane continued down the runway skidding on the left wing. The airplane veered left and impacted an FAA glideslope equipment building and antenna. Both the nose gear and right main gear then collapsed, and the airplane came to a stop.

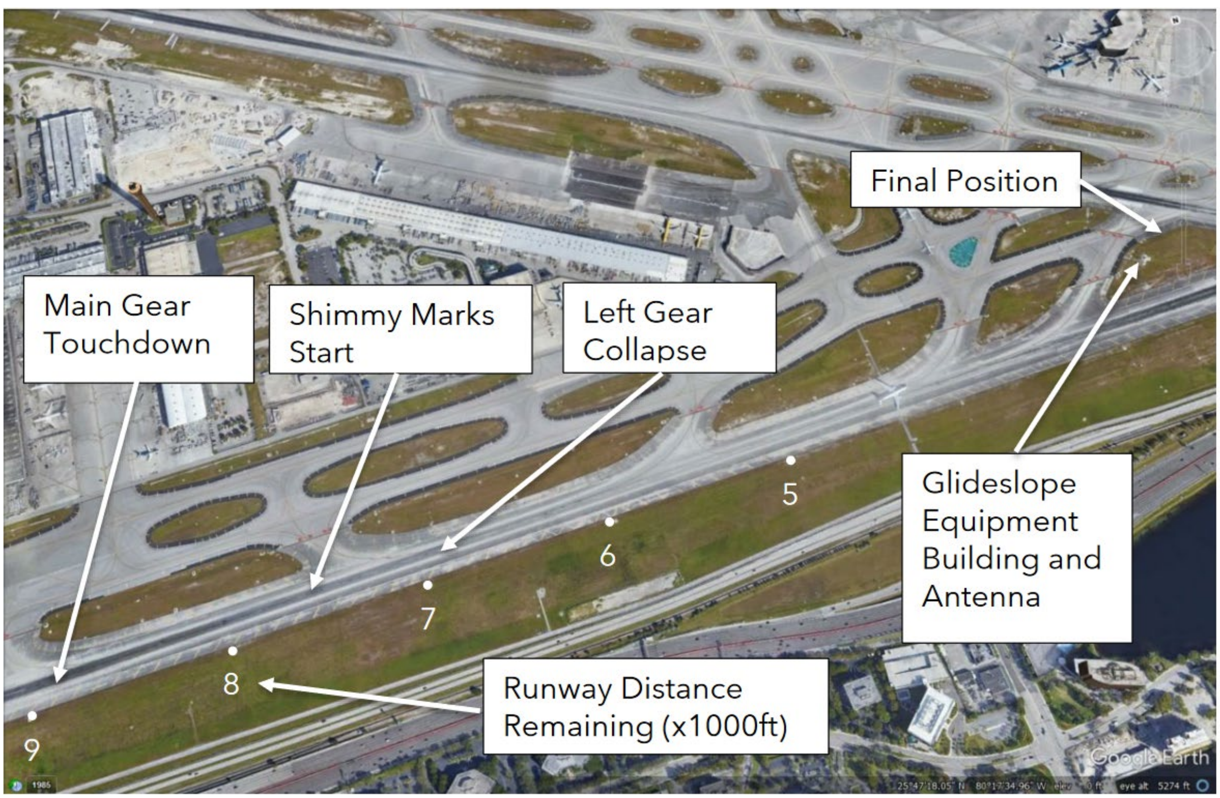

Figure 1 Runway 09 overview

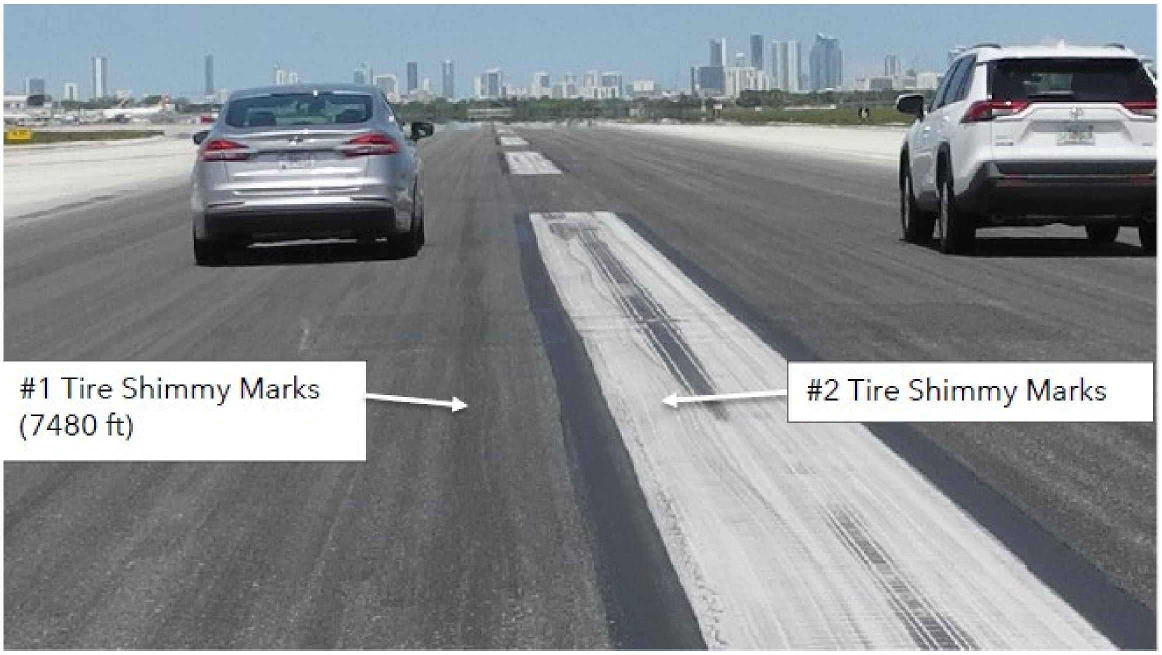

Figure 2 Start of left main gear shimmy marks

Figure 3 Shimmy marks continue

Figure 4 Shimmy marks continue

Figure 5 Shimmy marks continue

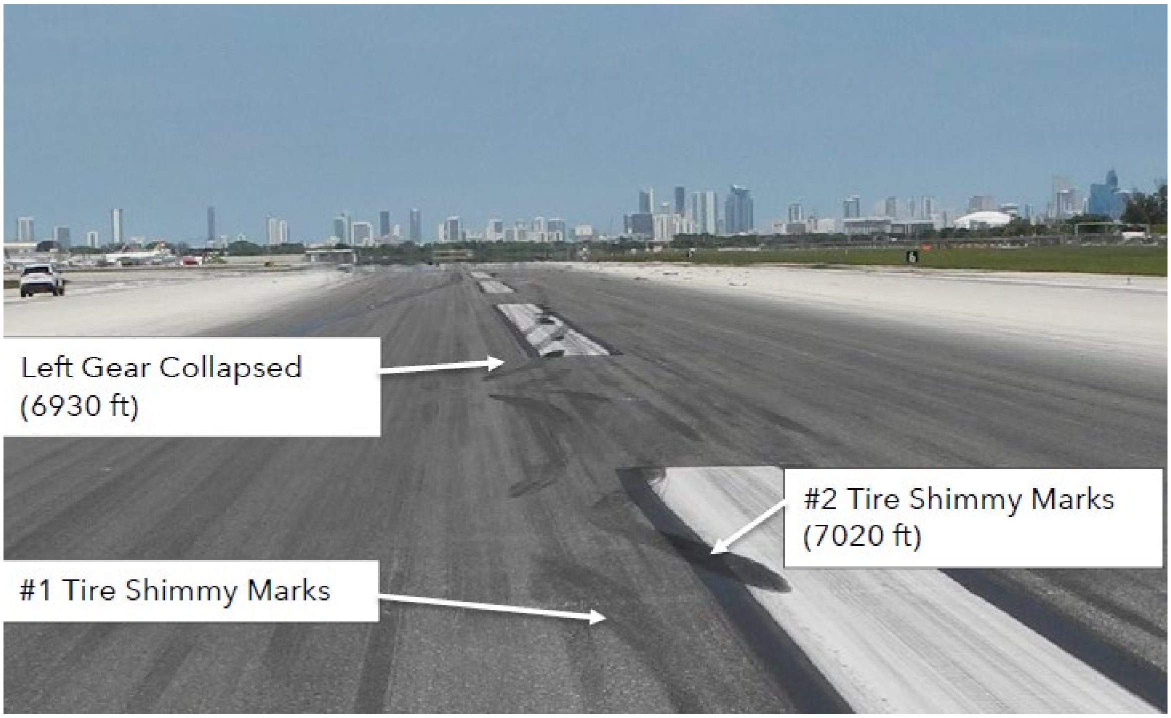

Figure 6 Shimmy marks continue

Figure 7 Shimmy marks continue

Figures 2 – 7[8] show how the rubber deposits on the runway for the left main gear tires started with a small oscillation and grew in amplitude (increasing shimmy). The labels with distance indicate approximate distance of runway 09 remaining. The tire marks changed in appearance. The initial markings were continuous and consistent with side-to-side oscillations (Figures 2 through 6). Figure 5 shows the location of the first debris found on the runway (approximately 7060 ft of runway remaining). The debris was a small piece of rubber, later determined to be from the outboard side of the #2 tire. The markings then were more arched and non-continuous, consistent with the axle/wheels turning about the vertical axis (Figure 6). The markings then changed from a two-tire pattern to a single tire pattern, and to the opposite side of the runway centerline, consistent with the tire sidewall contacting the runway after the left main landing gear collapse (Figure 7).

The tire marks on the runway confirm that a shimmy condition developed in the left main landing gear shortly after touchdown. The magnitude of the shimmy grew as the aircraft traveled down the runway, until it reached the point that the left main gear failed and collapsed.

[8] Figures taken from NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, pages 4-8

Examination of Landing Gear at Accident Site

Refer to Figure 8 for the major landing gear components and locations of the fracture faces.

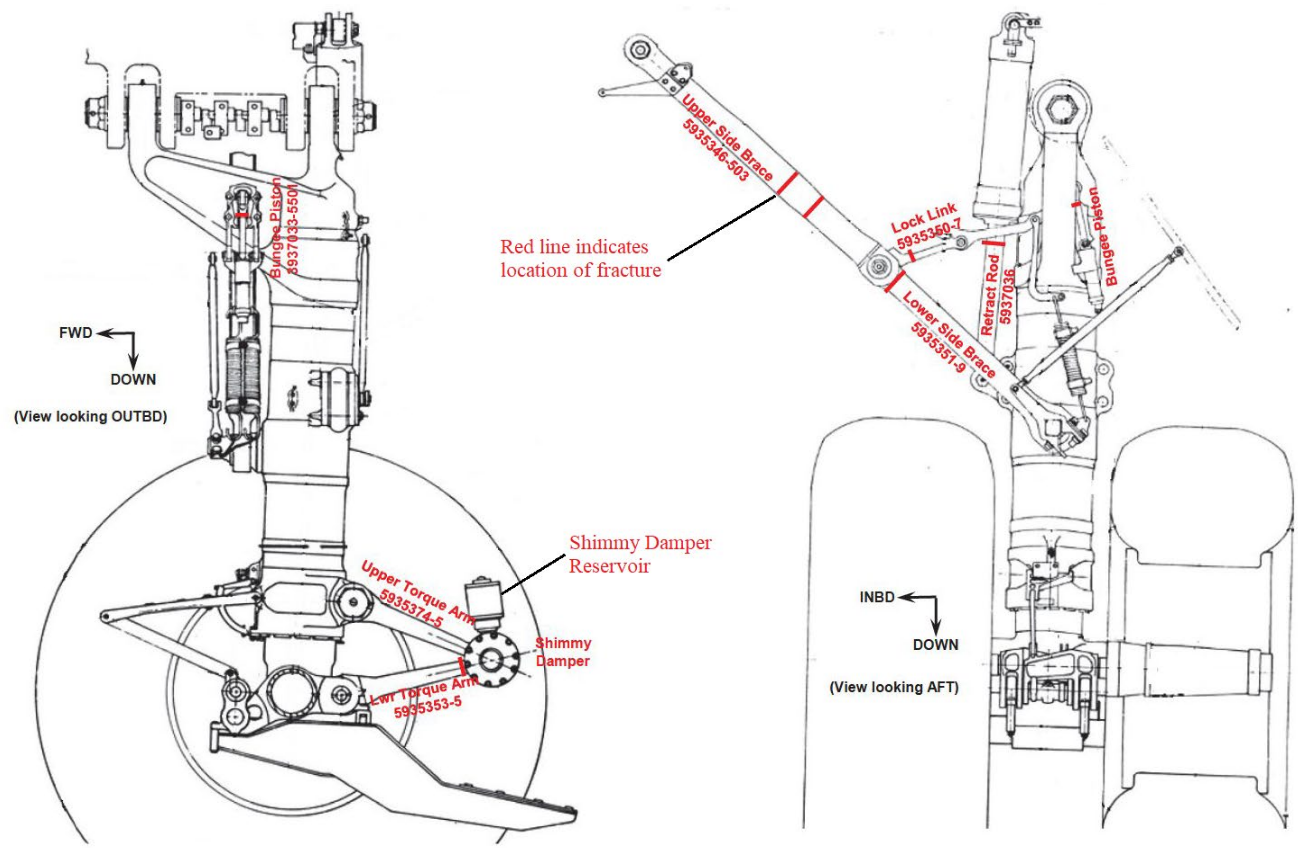

Figure 8 Locations of Fractures on Left Main Gear

The left main landing gear was found collapsed into the wheel well. When the airplane was lifted, the gear extended and the axle was found to be rotated 90 degrees outboard (see Figure 9). The lower side brace fractured below the joint of the upper and lower side braces. The upper side brace fractured into three pieces with the largest upper piece remaining attached to the airplane while the two smaller pieces were found in the debris field.

Figure 9 Left Main Gear

The upper torque link remained attached to the inner cylinder, with the shimmy damper housing attached to it. The bulk of the lower torque link remained attached to the landing gear axle, with the end fractured where it should attach to the upper torque link.

The left main landing gear shimmy damper hydraulic fluid reservoir became detached from the damper during the accident sequence. During a search of the runway area, pieces of the reservoir were found in the recently mowed grass area adjacent to the runway. The reservoir was in many pieces and appeared to have damage consistent with impact from mower blades as shown in Figure 10. The area where the reservoir is threaded into the damper housing had a large impact mark which deformed the area, and the threads were stripped.[9]

[9] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, page 20

Figure 10 Shimmy damper hydraulic reservoir pieces

The right main landing gear was found collapsed into the wheel well. The gear dropped to an almost down and locked position when the airplane was lifted. All components were intact and undamaged except that the bungee cylinder upper hydraulic tube was fractured, and the lock links position was slightly short of center.

There was substantial structural damage to the nose wheel well. The nose landing gear was folded aft with the tires lodged in the forward electronics bay. After the airplane was moved, and the airplane supported on jacks, the recovery team dislodged the nose gear and it extended.[10]

Lab Examination of Left Main Landing Gear

The left main landing gear and upper side brace was removed from the airplane and sent to the Boeing laboratory at Huntington Beach, California, for a detailed examination. The fracture faces of these failed components were inspected to identify failure modes and the shimmy damper housing was disassembled for examination.

The lower torque arm exhibited two transverse fractures which intersected the upper lug hole. Both of the fracture halves closest to the upper end were relatively smooth and smeared in an inboard/outboard direction. The fracture surfaces occurred along an oval/elliptical path, indicating that the fracture may have occurred due to a combination of compression and

[10] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, pages 9-12, 26, 31

bending/shearing. Scanning Electron Microscope (SEM) analysis of the fracture surfaces showed evidence of ductile separation.[11]

The bulk of the lower side brace remained attached to the landing gear outer cylinder and exhibited a complete transverse fracture approximately 4.1 inches from the upper end. SEM analysis of the lower side brace link revealed evidence of intergranular separation to a crack depth of 0.05 inches. This region appeared oxidized. The remainder of the fracture exhibited evidence of ductile separation.[12]

The upper side brace exhibited two complete transverse fractures located approximately 10 and 15 inches from the lower end. Both fractures initiated from areas of mechanical damage. Visual and SEM analysis of the fracture faces showed evidence of ductile separation. At the fracture 10 inches from the lower end, SEM analysis showed the majority of the fracture origin was smeared from post fracture damage. All undamaged observable regions exhibited evidence of ductile separation. At the fracture 15 inches from the lower end, SEM analysis revealed evidence of ductile separation.[13]

The retract cylinder rod was still attached to the outer cylinder. The rod exhibited a complete circumferential fracture approximately 16 inches from the attached end. The rod was bent in an outboard direction. SEM analysis of the fracture surface revealed evidence of ductile separation.[14]

The lower lock link exhibited a complete transverse fracture through the arm approximately four inches from the inboard end, and was bent in an upward and aft direction. The upper lock link was bent in a forward direction. SEM analysis of each fracture surface showed evidence of ductile separation. A majority of dimple formations were shallow and stretched, typical of ductile separation due to shear loads.[15]

The bungee piston rod exhibited a complete fracture approximately two inches form the end of the clevis lug. SEM analysis of the fracture surface showed evidence of ductile separation.[16]

Witness marks on the main landing gear cylinder and side brace links indicated that the side brace assembly had become hyper-extended and crossed over the cylinder during the incident.[17]

The laboratory examinations of the landing gear showed that the primary structural elements failed by overload and ductile separation. There was no evidence of pre-existing damage or fatigue cracking contributing to the gear failure.

The probable sequence of the left main landing gear collapse is as follows:

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[11] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, Attachment 1 pages 3 and 4

[12] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, Attachment 1 page 5

[13] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, Attachment 1 page 5

[14] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, Attachment 1 pages 5-6

[15] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, Attachment 1 page 6

[16] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, Attachment 1 page 7

[17] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, Attachment 1 pages 2-8

Shortly after the left main landing gear touched down on the runway, a shimmy began to develop. The magnitude of the shimmy condition grew, first causing the failure of the left main landing gear lower torque link. After the lower torque link failed, severe axial (inboard/outboard) oscillations occurred, resulting in the failure of the lower lock link. When the lower lock link failed, the side braces were free to, and did, fold in the opposite direction than during normal operation (i.e. they hyperextended) as the left main landing gear collapsed and folded inboard. As the landing gear folded inboard, the hyperextended side braces contacted the left main landing gear outer cylinder, causing the upper side brace to fracture near the hinge joint of the upper and lower side braces.

Shimmy Damper Housing Examination

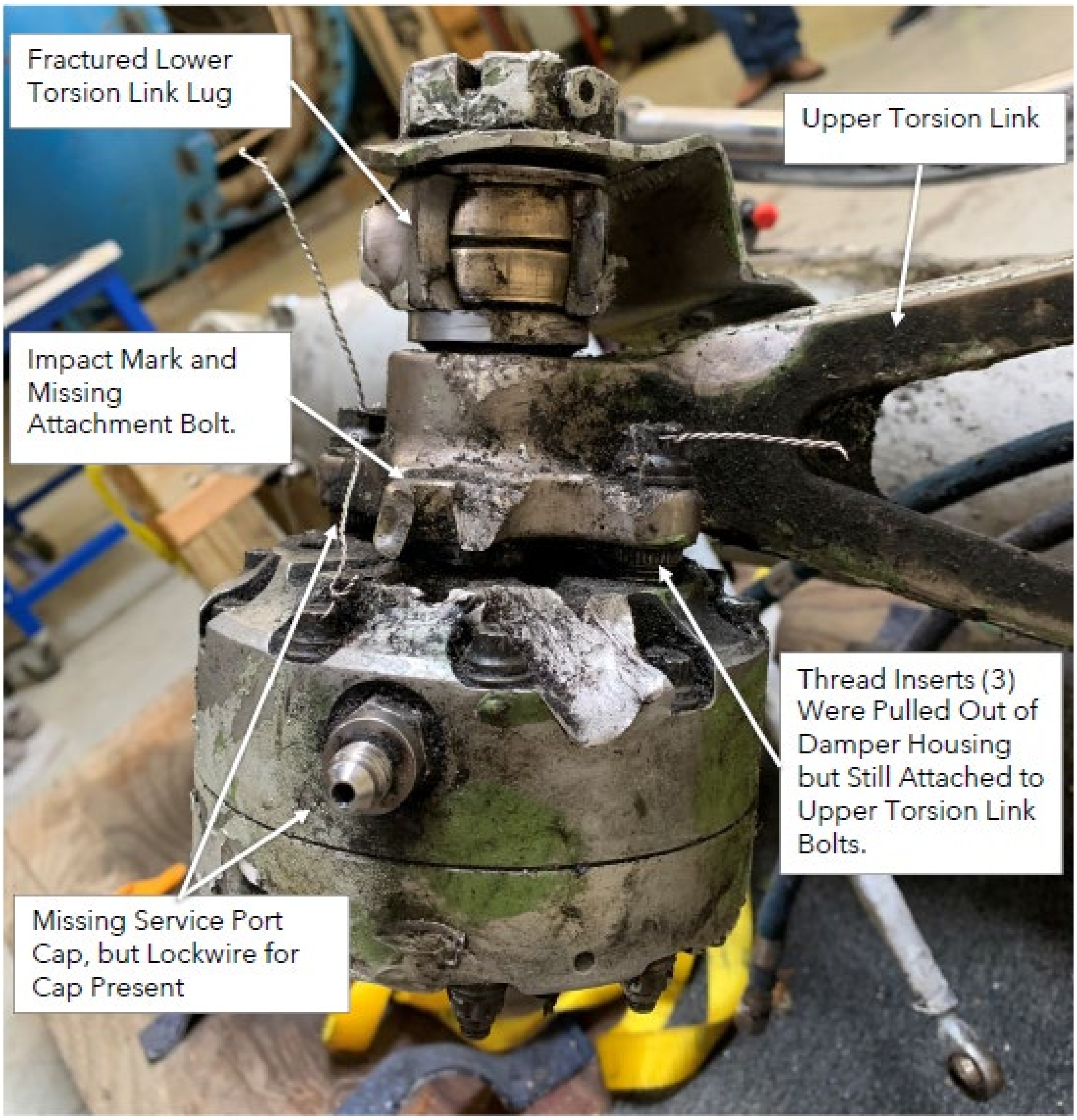

Figure 11 Shimmy Damper Examination[18]

[18] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, page 20

The exterior of the shimmy damper housing showed several significant impact marks (Figure 11). The cap was noted to be missing from the servicing port, however the lockwire was still attached to the housing with an intact loop which would have been connected to the cap.

The shimmy damper housing was disassembled, and the apex bolt was found to be bent and had to be cut. The internal components of the shimmy damper were found to be installed properly and undamaged with the exception of one Belleville washer which was found fractured. The fracture in the washer was examined and found to be ductile separation. The fluid passages in the damper were checked and confirmed to be unblocked.

In general, the internal components of the shimmy damper were found to be properly installed. No damage or defects were discovered which would have negatively impacted the shimmy damper's performance.

The check valve/servicing port was removed from the housing, and as noted, there was no cap on the valve. Computed Tomography (CT) was performed on the check valve. The CT results for the component showed that[20]:

1. The Poppet was not centered
2. The Spring was not centered, and spring coils overlapped at the top of the spring near the retainer end
3. The Spring was intact
4. There were no indications of foreign objects or debris in the check valve

The check valve was then tested at the manufacturer (Crissair). Prior to cleaning, the valve passed the 5 psig allowable leakage rate (at 1 drop/3 minutes). An additional test was performed at 50 psig, which was not in the Acceptance Test Procedure (ATP), and it leaked at 6 drops/3 minutes. The next ATP test for allowable leakage rate was performed at 1000 psig. A leakage of 6 drops/3 minutes was measured. The allowable limit is a trace of liquid, so it failed this test. The check valve was reversed and the crack pressure was tested and passed. The valve was then flushed (cleaned). The leakage tests were performed after cleaning and all failed: 5 psig (2drops/3min), 50 psig (3.8cc/3min), 1000 psig (20cc/min)[21].

Post-accident examination of the shimmy damper was unable to determine if the shimmy damper was properly serviced with hydraulic fluid at the time of the accident. Because the hydraulic fluid reservoir departed the shimmy damper housing during the accident sequence, it is not known if there was hydraulic fluid in the damper. The servicing port cap was found to be missing from the damper though the cap lockwire was intact. The servicing port check valve was also found to leak fluid during component testing. With the servicing port cap missing and check valve leaking, it is possible that there was not adequate hydraulic fluid in the shimmy damper for it to function as designed to dampen the shimmy in the landing gear.

[20] NTSB Computed Tomography Specialist's Factual Report dated January 31, 2023, page 6

[21] NTSB Systems and Structures Group Chairman's Factual Report dated May 12, 2023, page 25

KNOWLEDGE GAINED DURING THE INVESTIGATION (Findings)

The following knowledge gained is pertinent to drawing conclusions:

- Landing gear shimmy is torsional vibration of the landing gear. The MD-80 has design features to counteract and prevent main landing gear shimmy, including a shimmy damper

- A shimmy is more likely to develop in the landing gear with higher speed landings, lighter gross weight, and higher initial braking. A soft touchdown may also contribute to shimmy development as the landing gear strut remains uncompressed longer and the shimmy damper is less effective

- The shimmy damper is designed to prevent excessive vibration or shimmy buildup in the main landing gear. It is a hydraulic damper separate from the airplane hydraulic system which requires independent servicing with fluid. It will not function properly to dampen a shimmy condition if the hydraulic fluid level is low or empty.

- The touchdown was smooth, as described by the flight crew in their interviews and shown by FDR data
- Shortly after touchdown, a shimmy developed in the left main gear
- The left main gear shimmy grew in magnitude until the left main landing gear failed and collapsed
- On inspection after the accident, the left main gear shimmy damper service port cap was found to be missing from the shimmy damper. The cap was never located
- A laboratory examination of the shimmy damper housing found no anomalies which likely contributed to shimmy event
- During lab testing the shimmy damper service port check valve was found to leak fluid at all pressures tested
- Because the shimmy damper reservoir became detached from the shimmy damper housing during the accident sequence, it was not possible to determine if there was adequate hydraulic fluid in the shimmy damper at the time of landing

CONCLUSIONS

Boeing believes that the evidence supports the following conclusions for the accident:

This accident resulted from a shimmy condition which developed in the left main landing gear shortly after touchdown. The soft landing and immediate brake application increased the likelihood of a shimmy developing. It was not possible to determine definitively if the left main gear shimmy damper was fully serviced with hydraulic fluid at the time of the landing, however the missing service port cap and leak rate testing results of the check valve indicate it is possible that there was not enough hydraulic fluid in the shimmy damper for it to function as designed and arrest the shimmy condition.