Aviation Investigation Final Report

Location:	New York, New York	**Accident Number:**	DCA19LA134
Date & Time:	April 10, 2019, 20:40 Local	**Registration:**	N114NN
Aircraft:	Airbus A321	**Aircraft Damage:**	Substantial
Defining Event:	Abnormal runway contact	**Injuries:**	110 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

This accident occurred when an American Airlines Airbus A321 entered a left roll during takeoff from runway 31L at John F. Kennedy International Airport. The wind at the time resulted in a 14- to 17-knot crosswind from the right, which was below the company's 35-knot crosswind limitation. The initial takeoff roll proceeded normally, with the captain (the pilot flying) applying left rudder pedal to counter the right crosswind. The captain stated that he kept the airplane near the runway centerline and that "everything was ok" when the airplane reached 80 knots. When the airplane reached the rotation speed of 156 knots while still on the ground, the captain made a large left rudder pedal input, from 8° to 25°, during a 1.5-second timeframe. In response to this large rudder pedal input, the airplane's heading deviated to the left, and its lateral acceleration increased to a maximum of 0.32 G.

During a postaccident interview, the captain stated the airplane made a "significant" turn to the left. The captain also stated that he was "looking at the runway edge" and knew he had to get the airplane into the air. Digital flight data recorder (DFDR) data showed that the sidestick was pulled to its full nose-up position and a right sidestick position. During the aft sidestick and right sidestick application to rotate the airplane, the rudder remained close to its full-left deflection for 3 seconds. As the nose of the airplane lifted off the ground, the airplane began to roll to the left, and the left roll rate accelerated as the main landing gear lifted off the ground, reaching a maximum of 37° left wing down as the captain moved the rudder and sidestick to full right and to full aft. These movements arrested the left roll and allowed the airplane to continue to lift off.

The large left roll angle immediately after liftoff resulted in the left wingtip striking the ground and a runway distance marker, part of which remained imbedded in the wingtip. Airbus engineering simulations performed as part of this investigation demonstrated that the several seconds of near-maximum left rudder generated a rolling moment after the gear had left the ground to impart the left roll rate that the DFDR recorded. No airplane flight control

abnormalities were noted, except for a left aileron deflection as the left wingtip scraped the ground. Thus, the left roll that occurred was in response to the captain's left rudder pedal input during rotation of the airplane. Also, Airbus' engineering simulations demonstrated that the airplane's deviation to the left while on the ground was in response to the captain's rudder pedal input; no abnormalities in the airplane's response were noted.

In addition, American Airlines conducted a study of 13 months of takeoffs and found that the accident flight had a larger heading change, roll angle, maximum commanded rudder, and duration of maximum commanded rudder than the other takeoffs in the data set. Even though the crosswind that was occurring during the accident takeoff was about one-half of the company's 35-knot crosswind limitation, the accident airplane had a greater maximum deflection and a greater duration of input compared with all the other flights in the data set, including several flights with takeoffs that occurred with a stronger crosswind than the crosswind during the accident flight. Thus, the accident captain's left rudder pedal input was excessive and not necessary for the crosswind that was present during the takeoff.

.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The captain's excessive left rudder pedal input during the takeoff ground roll, which caused a large heading deviation and a left roll upon rotation that resulted in the left wingtip striking the ground.

Findings

Personnel issues	Incorrect action performance - Pilot
Aircraft	Crosswind correction - Incorrect use/operation
Aircraft	Yaw control - Incorrect use/operation
Aircraft	Directional control - Not attained/maintained
Aircraft	Lateral/bank control - Not attained/maintained

Factual Information

History of Flight

Takeoff	Abnormal runway contact (Defining event)
Takeoff	Runway excursion

On April 10, 2019, about 2040 eastern daylight time, American Airlines flight 300, an Airbus A321, N114NN, experienced a left roll during takeoff from runway 31L at John F. Kennedy International Airport (JFK), Queens, New York. During the left roll, the airplane's left wingtip struck the ground and a runway distance marker on the left side of the runway. The flight crew completed the takeoff and safely returned to the airport 28 minutes later. None of the 110 occupants aboard the airplane were injured. The airplane sustained substantial damage. The regularly scheduled passenger flight was operating under the provisions of Title 14 *Code Federal Regulations* Part 121 from JFK to Los Angeles International Airport (LAX), Los Angeles, California. Night visual meteorological conditions prevailed at the time of the accident.

The day of the accident was the second day of a 2-day crew pairing. The flight crew had operated a flight that departed the previous night from LAX and arrived at JFK about 0700 on the day of the accident. The crew then went to a local hotel for scheduled rest. The crewmembers reported for the accident flight about 1 hour 15 minutes before departure. The first officer conducted the preflight walk-around, and both crewmembers reviewed the weather and route of flight. According to the captain, everything was "looking good."

The airplane pushed back from the gate on time. The crew selected the flaps 1 setting, taxied to runway 31L, and held short of the runway. The captain (the pilot flying) stated that the taxi was "exactly the way I had done it before."

According to the cockpit voice recorder (CVR), the tower controller cleared the flight to line up and wait at 2038:43, and the captain taxied the airplane onto the runway. The captain stated, during a postaccident interview, that the first officer (the pilot monitoring) noticed the windsock and reported that the flight could depart with the wind component.

At 2039:48, the controller cleared the flight for takeoff and reported that the wind was from 010° at 17 knots. According to the digital flight data recorder (DFDR), as the airplane accelerated during the takeoff roll, thrust was applied symmetrically, and no braking asymmetry and nose wheel steering inputs occurred. Left rudder pedal inputs ranged between 0° and 13° as the airplane accelerated, consistent with a right crosswind. The airplane's heading was 315°. During a postaccident interview, the captain reported that, when he applied left rudder, it felt as if he was using more force with his left leg. The captain further stated that he kept the airplane near the runway centerline and that, when the airplane reached at 80 knots, "everything was ok." (The CVR recorded the first officer's 80-knot callout at 2040:13.)

The first officer made the takeoff decision speed (V1) callout at 2040:30, indicating that the airplane had reached 150 knots. According to the captain, sometime between that callout and the first officer's rotate callout (which occurred less than 2 seconds later to indicate that the airplane had reached 156 knots), the airplane made a "significant" turn to the left. DFDR data showed that, as the airplane accelerated to 156 knots, the captain's left rudder input increased from about 8° to 25° during a 1.5-second period. The airplane's lateral acceleration increased from 0.11 to 0.32 G, and its heading started to veer left of course. The captain then applied full aft sidestick (airplane nose up) and right sidestick up to 16°.

At 2040:32, the captain's sidestick briefly changed from a right to left deflection before changing to the maximum right deflection as the nose landing gear weight-on-wheels parameter switched from ground to air. The rudder was deflected about 20° to the left. As the nose landing gear lifted off the ground, the airplane began to roll to the left. During a postaccident interview, the captain stated that he was "looking at the runway edge" and knew that he had to get the airplane into the air. The captain also stated that, as he rotated the airplane, it began to roll to the left, so he added right rudder and right aileron.

At 2040:33, both the captain's and the first officer's sidesticks moved to the maximum right deflection of 20° when the airplane was in a 3° left roll attitude and had an increasing left roll rate. The CVR recorded "dual input" (an automated alert) at 2040:34, indicating that both the captain and the first officer made sidestick inputs. At that time, the rudder moved through its neutral position as the commanded pitch returned to neutral and the pitch angle reached 10°. The airplane's left roll was 26° with an increasing left roll rate as the right main landing gear weight-on-wheels parameter changed from ground to air. The airplane's heading was 290°, 25° to the left of the runway centerline.

At 2040:35, the left roll reached a maximum of 37°, both sidestick controllers remained at the full right roll command position, and both sidesticks were moved the maximum nose-up position. One second later, the CVR recorded a sound consistent with a wing strike. DFDR data showed that the left aileron moved toward neutral without a corresponding change in the right aileron or sidestick control, consistent with the left aileron moving due to contact with the ground. The rudder pedals reached their full right position, and the left main landing gear weight-on-wheels parameter transitioned from ground to air as the roll angle began to decrease.

As the roll angle decreased toward wings level, the captain made a rudder pedal input to the left and moved his sidestick to its maximum left deflection. At 2040:37, the airplane's radio altitude was 27 ft, airspeed was 164 knots, and pitch was 20.4°. One second later, the rudder pedal began to move toward neutral, the captain's sidestick moved to the full right position, and sidestick pitch control moved forward through neutral as the airplane rolled to the left. At 2040:39, the first officer stated, "I don't know what's goin' on." The airplane reached a 20° left roll and a maximum pitch angle of 24° at 2040:40. The airplane then rolled back toward wings level, and its pitch angle began decreasing toward 14° during the next 2 seconds as the rudder pedal returned to its neutral position and the sidestick was moved to the maximum left position and then back to the neutral position. As the airplane's pitch angle decreased toward 14°, its vertical acceleration decreased to 0.58 G.

From 2040:41 to 2040:43, rudder pedal inputs ceased, and the rudder moved back to its neutral position. The captain's lateral sidestick inputs continued, and the airplane recovered from its previous 20° right roll attitude and climbed normally. At 2040:45, the captain stated, "what the (expletive) happened?" The first officer responded, "I don't know" and "the engines all…good." At 2040:59, the captain stated, "it just (expletive) rolled on me."

At 2047:37, the first officer stated, "it might not be a bad idea go back [to JFK]." About 1 minute 10 seconds later, the captain stated "you know, I think you're right." At 2049:20, the captain stated, "let's coordinate a return to ah Kennedy. You think?" The first officer responded, "yeah," "I don't' know…it's a tough call," and "I just wanted to put that out and let you think about that." At 2049:40, the first officer stated, "you don't wanna talk to maintenance…maybe kinda get the blessing from somebody else, maybe?" The captain responded by indicating that he wanted the airplane to return to the airport.

At 2049:57, the first officer contacted air traffic control; about 8 seconds later, he stated, "when we departed…as we rotated we had…a strong roll to the left and…as we climb[ed] out we decided we would like to return to Kennedy." The controller asked if the situation was an emergency. The first officer then asked the captain if they should declare an emergency, and the captain stated, "let's not declare an emergency, as long as the airplane is flying." At 2050:25, the first officer told the controller, "naw the airplane's flying great right now we'd just like to return to Kennedy have them check it out." The airplane leveled off at 20,000 ft, and the controller provided vectors for the flight back to JFK.

At 2050:52, the captain told the first officer that he wanted to transfer control of the airplane, and the first officer stated "got the airplane" about 1 minute later. At 2051:56, the controller contacted the flight crew to better understand what happened after the airplane departed. The first officer responded that the airplane rolled uncontrolled 45° to the left as the airplane rotated and that, after recovery, the airplane climbed normally. The first officer also noted that a "good" crosswind was occurring at the time.

At 2054:09, a flight attendant contacted the flight crew and stated that a passenger seated near the left wing had reported that the wing "looks dented" and "doesn't look normal." The captain replied, "I don't know what that means but it doesn't matter [because] we're going back." At 2100:34, the flight attendant called back and stated that the left wing looked as if it had sustained "a little damage." The remainder of the flight was uneventful, and the CVR recorded a sound consistent with landing at 21:08:36.

Pilot Information

Certificate:	Airline transport; Flight engineer; Private	**Age:**	58,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	January 2, 2019
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	December 21, 2018
Flight Time:	19654 hours (Total, all aircraft), 3005 hours (Total, this make and model), 2975 hours (Pilot In Command, all aircraft)		

Co-pilot Information

Certificate:	Airline transport; Flight engineer	**Age:**	58,Male
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	5-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	April 9, 2019
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 6, 2018
Flight Time:	10103 hours (Total, all aircraft), 1824 hours (Total, this make and model)		

According to American Airlines, the flight crewmembers had flown together eight times previously. Their most recent pairing occurred on a 2-day trip that began on November 13, 2018 (about 5 months before the accident flight). The captain stated that the first officer would speak up regarding any concerns in the cockpit. The first officer stated that he enjoyed flying with the captain and described him as “easy to work with.” The first officer also stated that the captain would ask for, and was receptive to, the first officer’s input.

Aircraft and Owner/Operator Information

Aircraft Make:	Airbus	**Registration:**	N114NN
Model/Series:	A321 231	**Aircraft Category:**	Airplane
Year of Manufacture:	2014	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	6046
Landing Gear Type:	Tricycle	**Seats:**	
Date/Type of Last Inspection:	April 10, 2019 Continuous airworthiness	**Certified Max Gross Wt.:**	205030 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:	18408.46 Hrs at time of accident	**Engine Manufacturer:**	IAE
ELT:	C126 installed, not activated	**Engine Model/Series:**	V2533-A5
Registered Owner:		**Rated Power:**	33000 Lbs thrust
Operator:		**Operating Certificate(s) Held:**	Flag carrier (121)

The accident airplane had been operated by American Airlines since the time of the airplane's April 11, 2014, registration. No minimum equipment list or configuration deviation list deferred maintenance items were noted on the flight release.

The airplane's flight control surfaces were electrically controlled and hydraulically activated. The horizontal stabilizer and rudder could also be mechanically controlled. The two pairs of rudder pedals, which were rigidly interconnected, provided mechanical control of the rudder. Mechanically interconnected handwheels on each side of the center pedestal were used to control the trimmable horizontal stabilizer, and a single switch on the center pedestal was used to set the rudder trim.

A sidestick was located at each pilot's lateral console. The sidestick was a fly-by-wire system that pilots used to directly control the airplane's pitch and roll and indirectly control yaw through coordinated turns. The controllers for each sidestick were not coupled mechanically, and each controller transmitted separate signals to the flight control computers based on pilot input. The computers interpreted pilot input and moved the flight control surfaces in response. According to the American Airlines *A319/320/321 Operations Manual*, regardless of the pilot's input, the flight control computers would prevent the airplane from exceeding the safe envelope for the pitch and roll axes.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:	JFK,22 ft msl	**Distance from Accident Site:**	1 Nautical Miles
Observation Time:		**Direction from Accident Site:**	101°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	15 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	330°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.95 inches Hg	**Temperature/Dew Point:**	11°C / -3°C
Precipitation and Obscuration:			
Departure Point:	New York, NY (JFK)	**Type of Flight Plan Filed:**	IFR
Destination:	Los Angeles, CA (LAX)	**Type of Clearance:**	IFR
Departure Time:	20:40 Local	**Type of Airspace:**	

JFK has an automated surface observing system (ASOS) that is augmented by tower personnel as needed. The ASOS was located about 1.5 miles northeast of runway 31L. The ASOS 1-minute data at 2039 showed the wind from 354° at 14 knots and a peak gust from 002° at 18 knots. The ASOS 2-minute average wind at 2040 was from 354° (true) at 16 knots with the peak gust from 356° at 20 knots, which indicated a crosswind component from 14 to 17 knots for runway 31L.

At 2051 (11 minutes after the accident), the ASOS reported the wind from 360° at 17 knots, visibility 10 miles or more, scattered clouds at 25,000 ft above ground level, temperature 10°C, dew point temperature -3°C, and altimeter 29.98 inches of mercury.

Airport Information

Airport:	John F Kennedy Intl JFK	**Runway Surface Type:**	Concrete
Airport Elevation:	12 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	31L	**IFR Approach:**	None
Runway Length/Width:	14511 ft / 200 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	8 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	102 None	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	110 None	**Latitude, Longitude:**	40.641387,-73.778053(est)

After the accident, American Airlines examined runway 31L and documented a left main landing gear tire mark that was 564 ft long, a right main landing gear tire mark that was 216 ft long, and a scrape mark from the left wingtip that was 323 ft long. The wingtip scrape marks began to the left of the runway edge marking and extended to the edge of the paved surface. The airplane's left wing impacted a distance remaining marker on the left edge of the paved runway surface.

American Airlines' examination of the airplane revealed that a portion of the marker support structure was lodged in the left wingtip (see figure 1). The left wing outboard slat, left aileron, left outboard flap, and underside of the left wingtip sharklet were damaged (see figure 2).

Figure 1. Left wingtip damage and portion of distance remaining marker support structure lodged in wingtip (Source: American Airlines).

Figure 2. Scrape damage to underside of left wing slat (Source: American Airlines).

Further examination of the airplane determined that the left wing had a permanent upward deflection starting about midspan of the left wing, resulting in the left wingtip being about 6 inches higher than the right wingtip. As a result, American Airlines retired the airplane from service and scrapped the airplane.

Additional Information

Airbus Handling Qualities Analysis

Airbus performed a handling qualities analysis to determine if the A321 responded correctly to the flight crew's inputs. For the analysis, Airbus used its A321 engineering simulator; the pilot inputs that the DFDR recorded during the takeoff; and the meteorological conditions, including the wind at the time of takeoff. Airbus found that the simulation response matched the DFDR response in both the lateral and longitudinal axes. Additionally, the lateral acceleration and runway heading deviation from the centerline followed the application of the rudder while the wheels were on the ground during the takeoff roll in both the simulation response and the DFDR response.

The Airbus handling qualities analysis also verified the airplane's response to the rudder, sidestick, and aft stick as the airplane rotated, the left roll initiated, the left roll reached its maximum value, and the airplane recovered. The analysis confirmed that the A321 airplane

nominally responded to the pilot inputs recorded on the DFDR and recovered from the left roll with the follow-on control inputs. No anomalies were found in the accident airplane's response, and no abnormal behavior was observed for the entire ground roll and takeoff.

American Airlines Takeoff Data Analysis

American Airlines examined A321 takeoff data for more than 270,000 company flights that occurred between March 2018 and April 2019. The analysis examined data specifically between the time that the airplanes reached an airspeed of 130 knots and the time that the airplanes reached a radar altitude of 50 ft. Of the more than 270,000 flights examined, only one had a higher maximum rudder deflection, yet more than 2,300 flights operated with a higher crosswind component than the accident airplane. Further, the accident flight's heading deviation was more than triple the next highest deviation.

American Airlines also examined the duration of rudder application for those flights that included a maximum rudder input that was greater than 50% during the takeoff interval from 130 knots to 50 ft agl. The accident flight had the longest duration of rudder application of all the flights examined. Several of the other flights experienced a larger crosswind component, with gusts as high as 43 knots, yet had neither the maximum rudder deflection nor the duration of rudder application as the accident flight. In addition, American Airlines examined the duration of rudder input versus a maximum rudder deflection greater than 50% between 0.5 second before rotation and 0.5 second after liftoff. The data showed that the accident flight had a greater maximum rudder deflection and greater duration of rudder application than any other flight in the data set.

Administrative Information

Investigator In Charge (IIC):	Bower, Daniel		
Additional Participating Persons:	Chris Moran; American Airlines; Dallas, TX John Deleeuw; APA; Dallas, TX Patrick Lusch; FAA; Washington , DC		
Original Publish Date:	July 22, 2022	**Investigation Class:**	3
Note:	The NTSB did not travel to the scene of this accident.		
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=99240		