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FINAL INVESTIGATION REPORT ON
SERIOUS INCIDENT TO M/S AIR INDIA LTD.
AIRBUS 321-211 AIRCRAFT
VT-PPU AT PUNE
ON 15TH FEBRUARY 2020

AIRCRAFT ACCIDENT INVESTIGATION BUREAU
MINISTRY OF CIVIL AVIATION
GOVERNMENT OF INDIA

FOREWORD

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2017, the sole objective of the investigation of an accident/serious incident shall be the prevention of accidents and incidents and not to apportion blame or liability. The investigation conducted in accordance with provisions of the above said rules shall be separate from any judicial or administrative proceedings to apportion blame or liability.

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. Consequently, the use of this report for any purpose other than for the prevention of future accidents or incidents could lead to erroneous interpretations.

INDEX

<u>Para</u>	<u>Content</u>	<u>Page No.</u>
1	FACTUAL INFORMATION	5
1.1	History of the Flight	5
1.2	Injuries to Persons	6
1.3	Damage to Aircraft	6
1.4	Other Damage	9
1.5	Personnel Information	9
1.5.1	Pilot-in-Command	9
1.5.2	Co-Pilot	10
1.6	Aircraft Information	11
1.7	Meteorological Information	17
1.8	Aids To Navigation	17
1.9	Communications	17
1.10	Aerodrome Information	19
1.11	Flight Recorders	20
1.11.1	Relevant DFDR data	20
1.11.2	CVR Analysis	22
1.12	Wreckage and Impact Information	22
1.13	Medical and Pathological Information	22
1.14	Fire	22
1.15	Survival Aspects	22
1.16	Tests and Research	22
1.17	Organisational and Management Information	22
1.18	Additional Information	23
1.19	Useful or Effective Investigation Techniques	23
2	ANALYSIS	24
2.1	Serviceability of Aircraft	24
2.2	Weather	24
2.3	Air Traffic Controller	24
2.4	Analysis of DFDR	25
2.5	Analysis of Tape Transcript	28
2.6	Operational Factors	28
2.6.1	Pilot Factor	28
2.6.2	Crew Handling of the Aircraft and Decision Making	29
2.6.3	ATC handling	29
2.7	Circumstances Leading to the Incident	30
3	CONCLUSIONS	30
3.1	Findings	30
3.2	Probable Cause of the Incident	30
4	SAFETY RECOMMENDATIONS	31

GLOSSARY

AAIB	:	Aircraft Accident Investigation Bureau, India
AMSL	:	Above Mean Sea Level
ARC	:	Airworthiness Review Certificate
ASR	:	Airport Surveillance Radar
ATPL	:	Air Transport Pilot Licence
ATC	:	Air Traffic Control
AUW	:	All Up Weight
C of A	:	Certificate of Airworthiness
C of R	:	Certificate of Registration
CAR	:	Civil Aviation Requirements
CPL	:	Commercial Pilot License
CVR	:	Cockpit Voice Recorder
DFDR	:	Digital Flight data Recorder
DGCA	:	Directorate General of Civil Aviation
ECS	:	Environmental Control System
FO	:	First Officer
FCOM	:	Flight Crew Operating Manual
FCTM	:	Flight Crew Training Manual
FRTOL	:	Flight Radio Telephone Operators License
hrs	:	Hours
IATA	:	International Air Transport Association
ICAO	:	International Civil Aviation Organization
IFR	:	Instrument Flight Rules
ILS	:	Instrument Landing System
LLZ	:	Localizer
MEL	:	Minimum Equipment List
MLG	:	Main Landing Gear
NDB	:	Non-Directional Beacon
NLG	:	Nose Landing Gear
NM	:	Nautical Miles
PA	:	Passenger Address
PF	:	Pilot Flying
PIC	:	Pilot in Command
PM	:	Pilot Monitoring
QRH	:	Quick Reference Handbook
RA	:	Radio Altitude
RESA	:	Runway End Safety Area
SB	:	Service Bulletin
SEP	:	Safety and Emergency Procedures Manual
VFR	:	Visual Flight Rules
VMC	:	Visual Meteorological Conditions
VOR	:	VHF Omnidirectional Range
UTC	:	Coordinated Universal Time

**FINAL INVESTIGATION REPORT ON SERIOUS INCIDENT TO AIR
INDIA, AIRBUS A321 AIRCRAFT VT-PPU AT PUNE ON 15/02/2020**

1. **Aircraft Type** : Airbus A321-211
Nationality : Indian
Registration : VT - PPU
2. **Owner** : Air India Limited, New Delhi, India
3. **Operator** : Air India Ltd., India
3. **Pilot – in –Command** : ATPL holder
Extent of injuries : Nil
4. **First Officer** : CPL Holder
Extent of injuries : Nil
5. **Place of Incident** : Runway, Pune Airport (ICAO: VAPO, IATA: PNQ)
6. **Date & Time of Incident** : 15th Feb 2020 & 02:38 UTC
7. **Last point of Departure** : Pune
8. **Point of intended landing** : Delhi
9. **Latitude/Longitude** : 18.5793° N / 73.9089° E
10. **Type of operation** : Scheduled Operation
11. **Crew on Board** : 07
Extent of injuries : Nil
12. **Passengers on Board** : 180
Extent of injuries : Nil
13. **Phase of operation** : Take off
14. **Type of Occurrence** : Tail Strike / Incursion

(All the timings in this report are in UTC unless otherwise specified)

1. FACTUAL INFORMATION

1.1 History of the Flight

On February 15, 2020, Air India A321-211 aircraft VT-PPU (MSN 4096) was operating flight AI-852, sector PUN - DEL. This was the second sector of the day for the aircraft. All crew (Flight and Cabin) for second sector (PUNE - DELHI) remained the same as of first sector (DEL-PUN). There were 02 cockpit crew, 05 cabin crew and 180 passengers on board. Crew had undergone BA Test at Delhi; both crew were tested negative.

After carrying out procedures and checks as per checklist and obtaining line up clearance from ATC, the aircraft was aligned on runway 10 (QFU-095 Degree) at 02:38:00 UTC with following configuration.

Aircraft configuration at Line Up

- Gross weight: 77.3t < MTOW (89t).
- CG :27.4%.
- Aircraft in Slats/Flaps configuration: 1+F (18°/10°).
- Trimmable Horizontal Stabilizer (THS) position: -0.2°.
- Ground spoilers armed.
- Auto brake "MAX" mode armed.

After lineup and obtaining positive takeoff clearance from ATC, takeoff roll was initiated using FLEX thrust at 02:38:42 UTC. As per PIC statement, Pune runway has a slope because of which other end of runway is not visible from runway 10. During takeoff roll, on reaching top of the runway slope, PIC saw a vehicle and a person standing next to vehicle on the runway. When PIC noticed the vehicle, aircraft speed was 120 Knots (Approx). As per PIC, he could not reject the takeoff as the vehicle was parked with a person standing next to it and distance between the aircraft and vehicle was very less.

The PIC immediately applied TOGA thrust and initiated early rotation to avoid collision with the vehicle. After getting airborne, PIC immediately informed Pune ATC about the presence of a vehicle on runway, due to which aircraft had to rotate early. As per ATC transcript, Crew also informed ATC that they are going to report the presence of vehicle on runway with company. As per PIC, cockpit crew never felt or realized that Aircraft tail might have scrapped the runway due early rotation since there was nothing unusual (Sound, etc) noticed during initiation of early rotation.

PIC also stated that after establishing the route and at around FL150, the seat belt signs were switched off. Thereafter, Cabin Supervisor came to the cockpit and flight crew

enquired the status of the cabin and passengers. Cabin Supervisor informed the crew that status of cabin and passengers was fine and nothing abnormal was noticed. However, Cabin Supervisor informed the flight crew that one of the cabin crew working in the Aft area did inform her that some abnormal sound was heard for a few seconds and thereafter everything was normal.

Since, the observation of Aft cabin crew were not definitive or specific, PIC contacted Pune ATC to confirm if they have observed any tail scrap / strike or have found any debris or scrap mark on runway. Pune ATC, after carrying out runway inspection informed VT-PPU that no debris or scrap mark have been found on the runway. Since all operational parameters and pressurisation of aircraft was normal, PIC decided to continue the flight to destination. The aircraft landed safely at Delhi.

After parking the aircraft at Delhi Airport and during external inspection by PIC, paint scrap marks on the tail portion of the aircraft were noticed by PIC. There was no fire and injury to any of the occupants on board the aircraft.

1.2 Injuries to Persons

INJURIES	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor/ None	02+05	180	Nil

1.3 Damage to Aircraft

The damage to the aircraft was limited to the AFT belly of the aircraft. Following damages were recorded during post flight inspection.

External Damage (Affected damaged Skin area)

- (i) Skin scrap mark were noticed on panel area between forward of FR65 to Aft of FR 69 and between STGR 42R to 42L.
- (ii) Skin scrap marks, material loss on skin and crack were observed in the area at location FR66, FR67 and FR68 at stringer 43L, 44 and 43R.
- (iii) Cracks and material loss were observed on skin at FR 66, FR 67 and FR 68.

- (iv) Some Cleats at FR66, FR67 & FR68 and at stringer 43L, 44 and 43R were also noticed having scrap marks (Visible from outside through gaps in external skin).
- (v) Drain mast found damaged.
- (vi) Drain Tube at FR70 was found to have minor scrap mark **but no damage observed on area aft of FR70.**

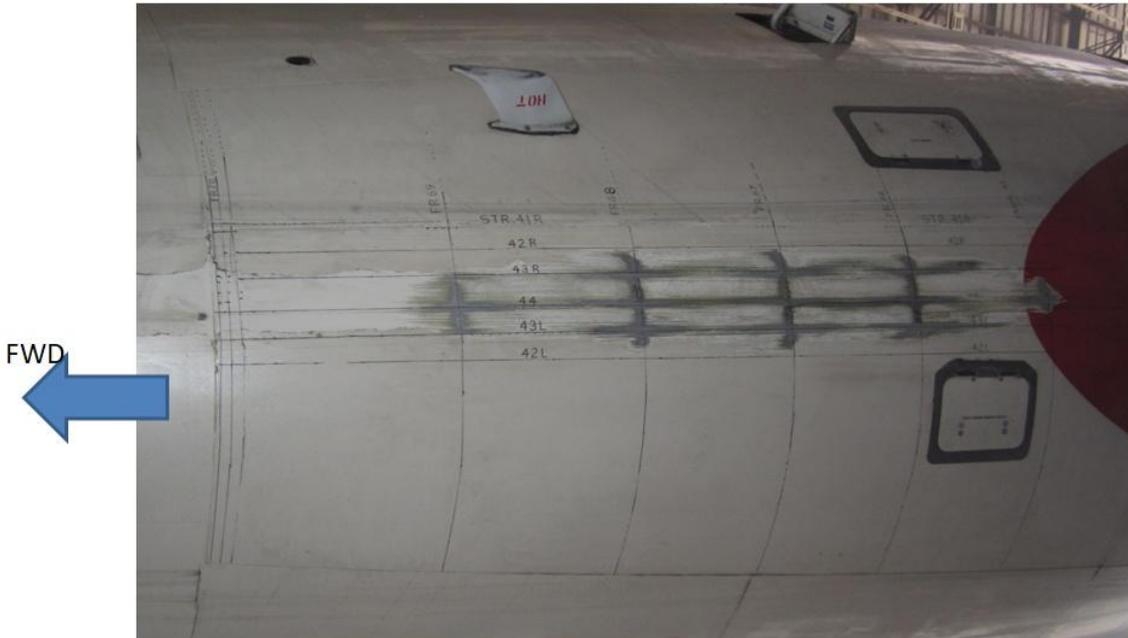


Fig-1: Photo graph of area affected due scrapping Fwd of FR 65 to aft of FR69

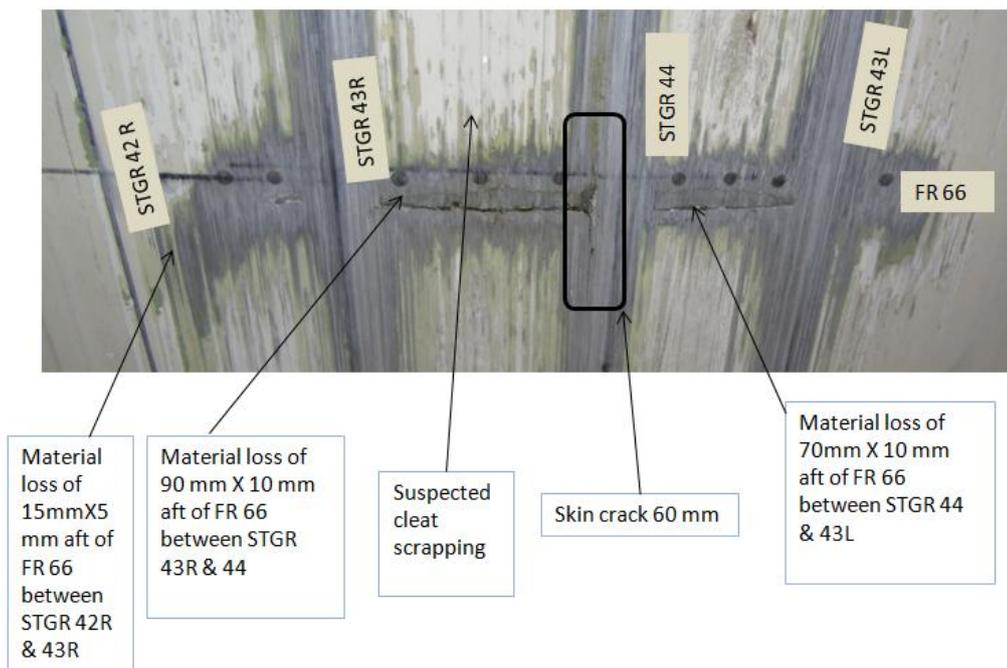


Fig-2: Photo graph of area Aft of FR 66

Internal Damage

- (i) No damage observed on corresponding Frames and Stringers at all places which were affected externally.
- (ii) No bending on cleats and no cracks observed, viewed from inside while inspection of Cleats - Location FR 66, FR 67, FR68 between STGR 43L to 43R.



Fig -3: Photographs of area fwd and aft of frames 65 to 67 (Viewed from Inside)

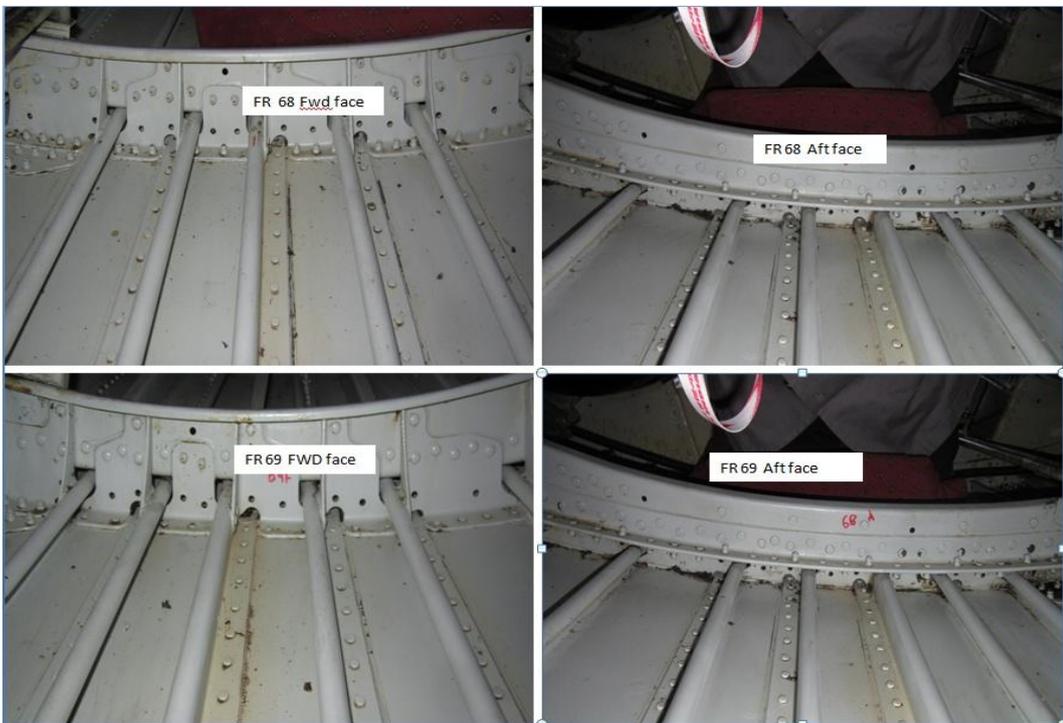


Fig -4: Photographs of area fwd and aft of frames 68 to 69 (Viewed from Inside)

1.4 Other Damage

Nil

1.5 Personnel Information

1.5.1 Pilot - In – Command (PIC)

Age	: 33 Yrs
License	: ATPL
Date of License Issue and Valid up to	: 23/03/2012 valid up to 22/03/2021
Category	: Multi engine
Class	: Land
Endorsements as PIC	: Cessna 152 A, Duchess 76, A320/A321/A319
Date of Joining Company	: 30/07/2007 (CTE) / 26/12/2008
Date of Endorsement as PIC on type	: 28/09/2017
Instrument Rating	: 15/10/2019
Date of RTR Issue and Validity	: 14/03/2010 and Valid
Date of FRTOL issue & validity	: 16/05/2007 and Valid
Date of Med. Exam & validity	: 18/01/2020 and Valid
Date of Route Check	: 11/09/2019
Date of Last Proficiency Check	: 15/10/2019
Date of English language Proficiency & Validity	: 16/12/2019 and Valid
Date of last CRM	: 05/12/2019
Date of last Monsoon training	: 04/04/2019
Date of Dangerous Goods Awareness Training	: 17/05/2019
Date of last Refresher/Simulator	: 14/10/2019
Simulator Training for Critical Emergencies	: 14/10/2019
Familiarity with Route/ Airport flown for last 12 months and since joining the company.	: Flown to the airport (Pune) for more than 10 times in last 12 months and 30 times since joining the company
Total flying experience	: 7090 Hrs

Total Experience on type	: 3670 Hrs
Total Experience as PIC on type	: 1670 Hrs
Last flown on type	: 14/02/2020
Total flying experience during last 01 Year	: 725 Hrs
Total flying experience during last 180 days	: 315 Hrs
Total flying experience during last 90 days	: 180 Hrs
Total flying experience during last 30 days	: 47 Hrs
Total flying experience during last 07 Days	: 08 Hrs
Total flying experience during last 24 Hours	: 01:56 Hrs
Rest period before the flight	: 12 Hrs

1.5.2 Co-Pilot

Age	: 25 years
License	: CPL
Date of License Issue and Valid up to	: 28/10/2019 up to 27/10/2024
Category	: Multi engine
Class	: Land
Endorsements as PIC	: DA 40 , DA 42
Date of Joining Company	: 13/02/2017
Date of Endorsement as PIC on type	: N/A
Instrument Rating	: 12988
Date of RTR Issue and Validity	: 18/03/2014 and Valid
Date of FRTOL issue & validity	: 28/10/2019 and Valid
Date of Med. Exam & validity	: 06/12/2019 and Valid
Date of Route Check	: 25/11/2019
Date of Last Proficiency Check	: 22/09/2019
Date of English language Proficiency & validity	: 6/11/14 (level 6)
Date of last CRM	: 25/09/2019
Date of last Monsoon training	: 23/01/2020
Date of Dangerous Goods Awareness Training	: 22/02/2019

Date of last Refresher/Simulator	: Simulator : 22/09/2019 Refresher : 23/01/2020
Simulator Training for Critical Emergencies	: 22/09/2019
Familiarity with Route/ Airport flown for last 12 months and since joining the company	: Flew to the airport (Pune) more than 6 times in preceding 12 months and more than 12 times since joining the company.
Total flying experience	: 2115:45 Hrs
Total Experience on type	: 1921:11 Hrs
Total Experience as PIC on type	: N/A
Last flown on type	: 13/02/2020
Total flying experience during last 01 Year	: 683:24 Hrs
Total flying experience during last 180 days	: 343:07 Hrs
Total flying experience during last 90 days	: 191:20 Hrs
Total flying experience during last 30 days	: 53:37 Hrs
Total flying experience during last 07 Days	: 18:60 Hrs
Total flying experience during last 24 Hours	: 00:00 Hrs
Rest period before the flight	: 34:24 Hrs

1.6 Aircraft Information

The A321-211 is a subsonic, medium-range, civil transport aircraft. The aircraft is fitted with two high bypass turbofan CF56-5B engines. The aircraft is designed for operation with two pilots and has been configured by M/s Air India for passenger seating capacity of 182.

The aircraft is certified in Normal (Passenger) category, for day and night operation under VFR & IFR. The maximum operating altitude of the aircraft is 39,100 feet and maximum takeoff weight is 89000 Kgs. The Maximum Landing weight is 75500 kg. The Aircraft length is 44.507 meters, wingspan is 34.1 meters and height of this aircraft is 11.755 meters. The distance between main wheel centre is 7.59 meters. The distance between engines is 11.51 meters and Engine Ground Clearance is 0.58 meters.

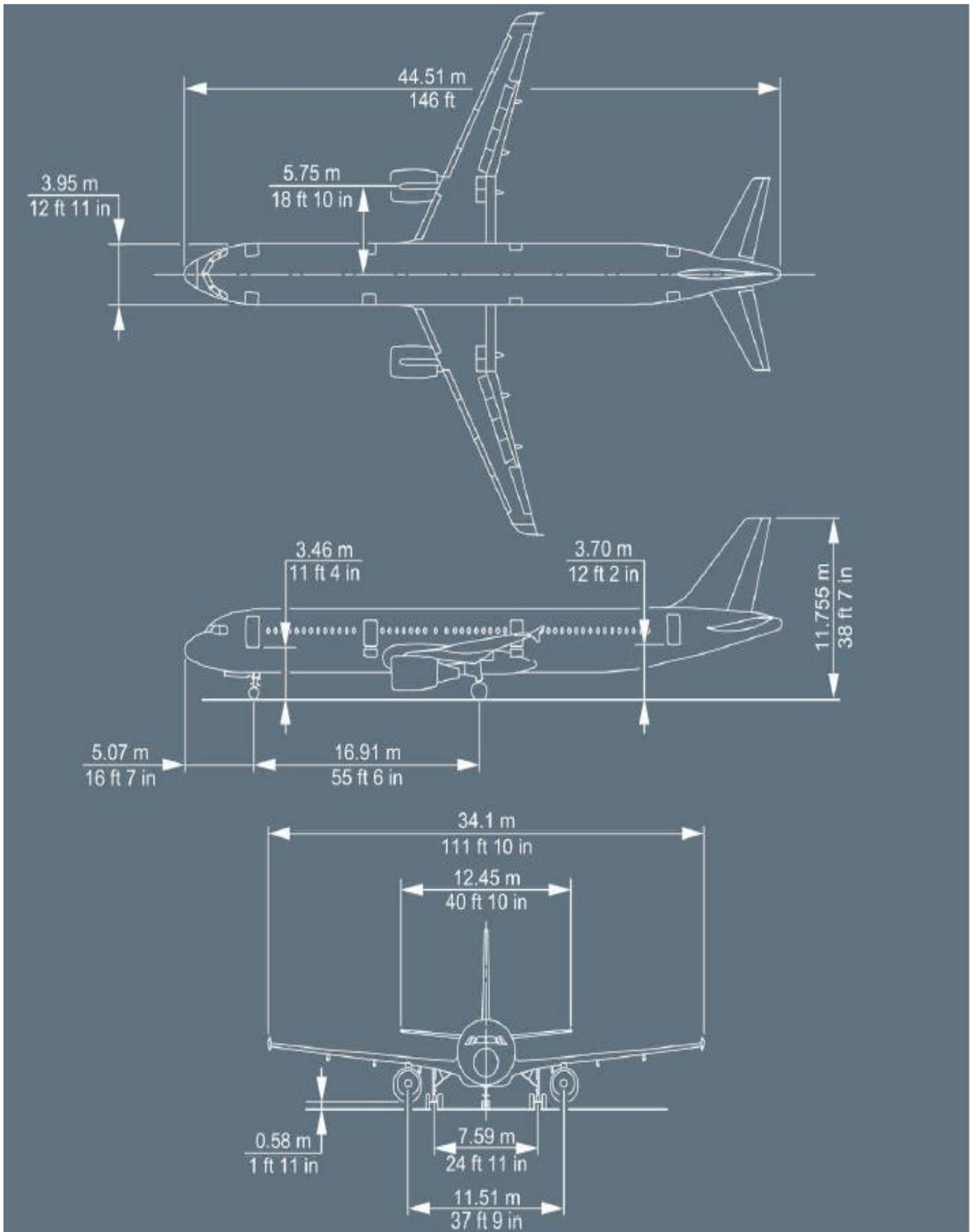


Fig-5: Three-D View Principal Dimensions of Airbus 321-211(VT-PPU)
(Reference: DSC-20-20 P6/14 Of FCOM Dt 14 Jan19)

Each CFM56-5B engines has a thrust rating of 32000lb and manufactured by SNECMA France. The principal modules of the engine are fan and booster, high pressure compressor, combustor chamber, high pressure turbine, low pressure turbine and accessory drive gearbox.

At the time of incident, the #1 PORT engine Serial Number 697888 had done 33068:01 HRS since New (TSN) and 20658 Cycles since New (CSN) and #2 STBD engine Serial Number 697831 had done 30046:04 HRS Time since New (TSN) and 19572Cycles since New (CSN).

Fuselage: The fuselage is a semi-monocoque structure. Light alloy circular frames and longitudinal stringers support and the primary fuselage skin. There are no longitudinal stringers in the nose assembly. The fuselage is made of different assemblies which are put together to make the complete fuselage shell. The assemblies are nose forward fuselage, forward fuselage, center fuselage, rear fuselage and cone/rear fuselage.

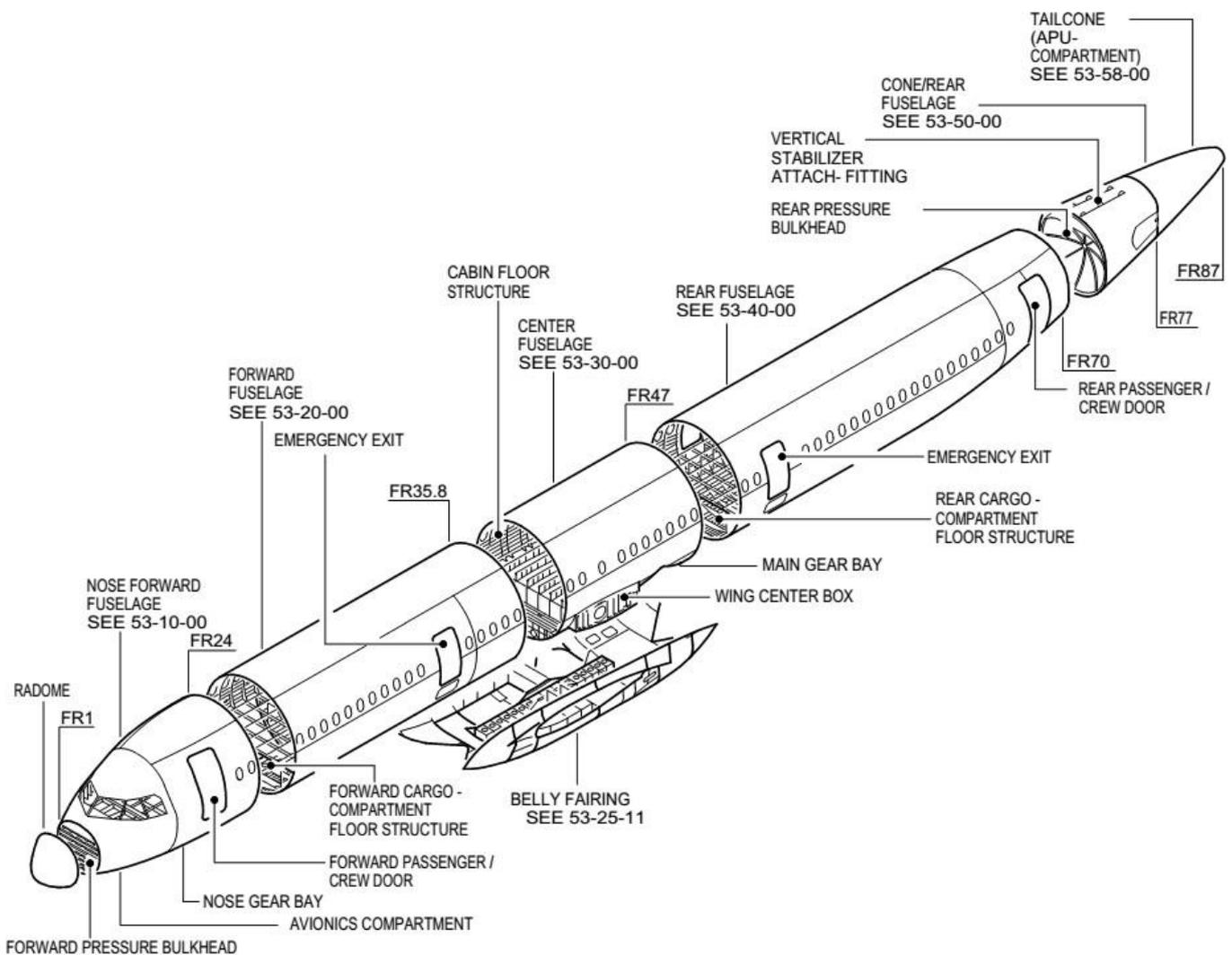


Fig-6: Fuselage sections

Frames 24, 35, 47 and 70 make the joints for the assemblies. Pressure bulkheads are installed at FR1 and FR70. The pressure bulkheads and the fuselage skin make the basic pressurized zone. The cockpit, cabin, avionics compartment and the FWD and AFT cargo-compartments are included in the pressurized zone.

The structure is made of frames, stringers and skin panels. They are riveted together to make the fuselage shell. Crossbeams make the shell stronger in the forward and aft fuselage. Support struts are attached to each end of the crossbeams. Longerons and seat tracks that are attached to the crossbeams make the cabin floor structure. The belly fairing primary structure is installed on the exterior of the lower fuselage between FR31/35 and FR48/FR53. It is an extension to the lower fuselage and contains the air-conditioning and hydraulic services equipment.

Airbus A321 aircraft VT-PPU (MSN 04096) was manufactured in year 2009. The aircraft is registered under the ownership of M/s Air India Ltd, New Delhi. The Certificate of Registration No. 4043/4 under category 'A' was issued on 27/11/2009. On the day of incident, the aircraft VT-PPU had logged 31692:15 airframe hours and 18140 landings.

The aircraft was issued Certificate of Airworthiness Number 6152 under NORMAL category, sub-division PASSENGER / MAIL / GOODS by DGCA which was valid till 31 Oct 2020. The aircraft Aero mobile License No. A-14027/14/2014-RLO (NR) was valid on the day of incident. The aircraft was being operated under Scheduled Operator's Permit No. S-09 which was valid till 30 Jun 2023. Prior to the incidented flight, the Aircraft was holding a valid Certificate of Flight Release.

The aircraft was last weighed on 23/11/2019 at Mumbai and the weight schedule prepared and duly approved by the office of Deputy Director General, DGCA, Mumbai. As per the approved weight schedule, the Empty weight of the aircraft is 47454 Kgs. Maximum Usable fuel Quantity is 18604.00 Kgs. Maximum payload with fuel and oil tanks full is 20603 Kgs. Empty weight CG is 16.14% meters aft of datum. As there has not been any major modification affecting weight & balance since last weighing, hence the next weighing was due on 23/11/2024. Prior to the incident flight the weight and balance of the aircraft was well within the operating limits.

The aircraft and Engines were being maintained under continuous maintenance as per maintenance program consisting of calendar period based maintenance and flying Hours / Cycles based maintenance as per maintenance program approved by O/o Deputy Director General, DGCA, Mumbai. Subsequently, all lower inspections (Preflight checks, Layover Checks, Weekly Checks) were carried out as and when due before the incident.

All the concerned Airworthiness Directives, mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine have been complied with as and when due.

All Transit Inspections were carried out as per approved Transit Inspection schedules. All higher inspection schedules include checks 1 inspection were carried out as per the manufacturer's guidelines as specified in Maintenance Program and are approved by the Continuing Airworthiness Manager (Post Holder for Continuing Airworthiness).

The defect records of the aircraft were scrutinized for a period of one month from the date of occurrence of the serious incident and no defect was pending on the aircraft prior to the incident flight.

Pitch Control

The A321 is a 'fly-by-wire' aircraft i.e. there is no direct mechanical link between most of the flight crew's controls and the flight control surfaces. Flight control computers send movement commands via electrical signals to hydraulic actuators that are connected to the control surfaces.

The controls include the sidestick controllers (or sidesticks) to manoeuvre the aircraft in pitch and roll. During manual flight, such as takeoff, the flight crew makes pitch control inputs using their sidesticks. Both captain's and first officer's sidesticks move independently and there is no mechanical link between them. The range of movement of the sidestick in pitch is $\pm 16^\circ$.

Rotation Technique

The extract from the operator's Flight Crew Training Manual on rotation technique is as follows:-

The rotation technique is similar on all fly-by-wire aircraft. To initiate the rotation, the flight crew performs a positive backward stick input. When the rotation is initiated, the flight crew achieves a rotation rate of approximately 3 °/s resulting in a continuous pitch increase. During the rotation, the aircraft liftoff occurs at approximately 10 ° of pitch, typically around 4 to 5 s after the initiation of the rotation. After the liftoff, the PF targets the required pitch attitude.

To monitor the rotation, the PF uses the outside visual references. Once airborne, the PF controls the pitch attitude target on the PFD.

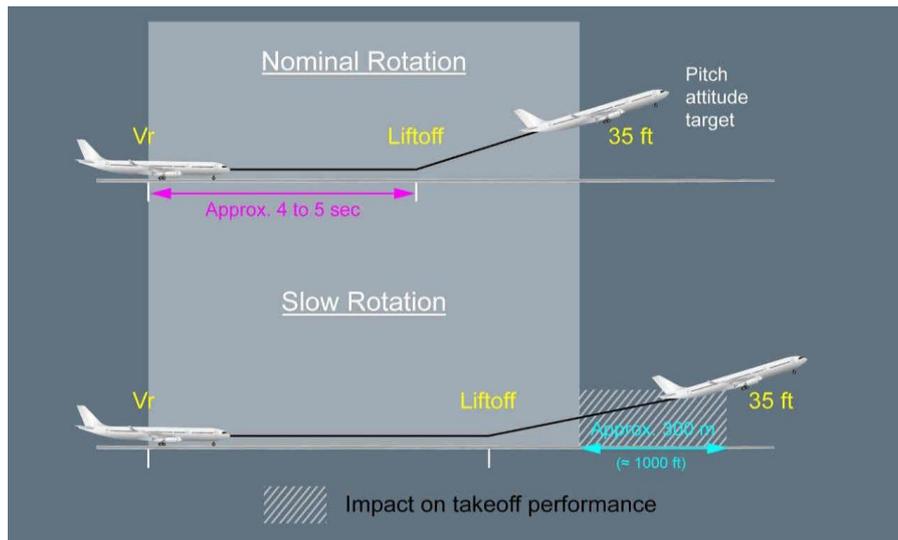


Fig -7: Performance impacts for a rotation rate of approximately 2 °/s

A slow rotation rate or an under rotation (below takeoff pitch target) has an impact on takeoff performance (refer fig-7):

- The takeoff run and the takeoff distance increase
- The obstacle clearance after takeoff decreases.

Tail Strike Avoidance

The extract from the operator's Flight Crew Training Manual (FCTM) on Tail Strike Avoidance is as follows:-

Introduction

It is particularly important for A321 operators. Tail strikes can cause extensive structural damage, which can jeopardize the flight and lead to heavy maintenance action. They most often occur in such adverse conditions as crosswind, turbulence, windshear, etc.

Main Factors Early Rotation

Early rotation occurs when rotation is initiated below the scheduled VR. The potential reasons for this are:-

- The calculated VR is incorrect for the aircraft weight or flap configuration.
- ***The PF commands rotation below VR due to gusts, windshear or an obstacle on the runway.***

Whatever the cause of the early rotation, the result will be an increased pitch attitude at liftoff, and consequently a reduced tail clearance.

Oleo Inflation

The correct extension of the main landing gear shock absorber (and thus the nominal increase in tail clearance during the rotation) relies on the correct inflation of the oleos.

Action in Case of Tail strike

If a tail strike occurs at take-off, flight at altitude requiring a pressurized cabin must be avoided and a return to the originating airport should be performed for damage assessment.

1.7 Meteorological Information

At the time of departure, 0230 hrs UTC, the following weather was reported by MET department.

Wind	:	01 Knots variable
Visibility	:	3000 m
Weather	:	Haze
Clouds	:	No Significant Clouds
Temperature	:	19.8 ⁰ C
Dew Point	:	15 ⁰ C
QNH	:	1017 hPa
Trend	:	No significant Weather Change

1.8 Aids to Navigation

All Navigational Aids fitted on the aircraft and installed at Pune / Delhi Airport were working satisfactorily.

1.9 Communications

There was always two way positive communication between the ATC and the aircraft.

TIME (in IST)	COMMUNICATION
0752.03H	AC: AI852 TOWER: AI852 PUNE AC: AI 852, SIR WE ARE TOTAL 187, HUNDRED AND EIGHTY SEVEN THROUGH SECURITY, WILL BE READY FOR START UP ANOTHER ZERO TWO NINE'S, WILL BE REQUESTING ONE ENGINE START UP AT BAY DUE TECHNICAL. WE WILL TAKE ALL GROUND PRECAUTIONS AND REQUEST RUNWAY 10 DEPARTURE.
0752H	TOWER: AI852, ONE ENGINE START UP AT BAY IN CORDINATION WITH APRON, RUNWAY 10 AVAILABLE.
0752H	AC: THANK YOU SIR, WE WILL CALL YOU FOR PUSH BACK
0759.50 H	AC: AI 852, REQUESTING PUSH BACK, START, CLEARANCE TOWER: AI 852, PUSH BACK, START UP APPROVED, RUNWAY 10 AC: PUSH BACK AND START UP APPROVED, RUNWAY 10, AI 852
0805.14H	AC: PUNE TOWER AI 852, REQUESTING TAXI, INSTRUCTIONS TOWER: AI 852, TAXI RUNWAY 10, P-P2, QNH-1017 AC: QNH 1017, P-P2, HOLDING POINT RUNWAY 10, AI 852
0806H	TOWER: AI 852, CLEARANCE AC: GO AHEAD, SIR, 852 TOWER: AI 852, CLEAR TO DESTINATION DELHI PALAM, AS PER FLIGHT PLAN ROUTE, FLIGHT LEVEL 330, DEPARTURE RUNWAY 10, AFTER DEPARTURE TURN LEFT, CLIMB ON TRACK LEVEL 80, SQUAWK 6340 AC: AI 852 CLEAR DESTINATION VIA FLIGHT PLANNED ROUTE FL 330 DEPARTURE RWY 10, TURN LEFT CLIMB ON TRACK TO LEVEL 80, 6340 ON SQUAWK AI 852 TOWER: AI 852, READ BACK CORRECT, LINE UP 10, REPORT READY AC: LINE UP RWY 10, WILL CALL YOU READY, AI 852
0807.50H	AC: DEPARTURE AI 852 TOWER: AI 852, CLEAR FOR TAKEOFF
0808.54H	AC: AI 852 TOWER: VEHICLE ENTERED WITHOUT PERMISSION, WE ARE RAISING REPORT AC: AI 852
0810.07H	AC: PUNE AI 852 TOWER: AI 852, PUNE AC: SIR, JUST FOR YOUR INFORMATION SIR, THIS IS NOT ACCEPTABLE SIR, WE HAVE A SERIOUS ISSUE, WE HAVE TO ROTATE BEFORE OUR SPEED, OTHERWISE WE WOULD HAVE CRASHED INTO THE RWY CRASHED INTO THE VEHICLE ON BOARD, ON THE RUNWAY TOWER: ROGER, SIR, APOLOGISE SIR, WE ARE RAISING A REPORT
0810.35 H	TOWER: 852 WE ARE INITIATING ACTION AGAINST THE VEHICLE AC: COPIED SIR, WE WILL FILE THE REPORT ACCORDINGLY WITH THE COMPANY AS WELL TOWER: ROGER

0812.08H	<p>AC: PUNE, AI 852, IN CONTACT WITH MUMBAI, CLEARED US CLIMB TO LEVEL 140 IN CORDINATION WITH <i>MUMBAI</i></p> <p>TOWER: AI 852, ROGER, CLIMB FLIGHT LEVEL 140, REPORT ETA</p> <p>AC: AI 852, CLIMB 140, ETA DELHI 0418</p> <p>TOWER: AI 852, ROGER, FREQUENCY CHANGED APPROVED, JAI HIND</p> <p>AC: FREQUENCY CHANGED APPROVED, GOOD DAY, JAI HIND SIR</p>
0821.53H	<p>AC: PUNE, AI 852</p> <p>TOWER: AI 852, PUNE</p> <p>AC: JUST TO CONFIRM, COULD YOU PLEASE ASK THE FOLLOW ME TO CHECK THE RUNWAY FOR THE INSPECTION IF WE HAD ANY TAIL STRIKE, BECAUSE OUR PARAMETERS AS OF NOW ARE NORMAL DUE TO EARLY ROTATION WE CAN SUPSPECT TAIL STRIKE, IF YOU CAN CHECK IT UP LET US KNOW</p> <p>TOWER: ROGER, STAND BY</p>
0825.31H	<p>TOWER: AI 852, PUNE</p> <p>AC: SIR AI 852</p> <p>TOWER: AI 852, NO MARKING OBSERVED ON RUNWAY</p> <p>AC: COPIED SIR THANKYOU</p> <p>TOWER: REMAIN THIS FREQUENCY FOR 1-2 MINUTES</p>
0827.01H	<p>TOWER: AI 852, FULL INSPECTION HAS BEEN CARRIED OUT, ALL ALONG RWY, NO MARKING OBSERVED</p> <p>AC: SIR TIME PERMITTING CAN YOU LET US KNOW THE DETAILS OF THE VEHICLE SO THAT WE CAN FILE THE REPORT ACCORDINGLY</p> <p>TOWER: WILL CONTACT ON LIMA LIMA</p> <p>AC: COULD WE HAVE THE LIMA LIMA, CALL YOU AFTER LANDING</p> <p>TOWER: 02026684434</p> <p>AC: THANKS CALL YOU FROM DELHI</p> <p>TOWER: REQUEST CONTACT AFTER LANDING AT DELHI, JAI HIND</p>

1.10 Aerodrome Information

Pune Airport, (IATA: PNQ, ICAO: VAPO) is located approximately 10 km (6.2 mi) northeast of Pune Central in the state of Maharashtra, India. The airport is a civil enclave operated by the Airports Authority of India at the western side of Lohegaon Air Force Station of the Indian Air Force. The airport serves both domestic and international flights. The elevation (AMSL) of the airport is 592 m / 1,942 Ft and coordinate 18°34'56"N 073°55'11"E.

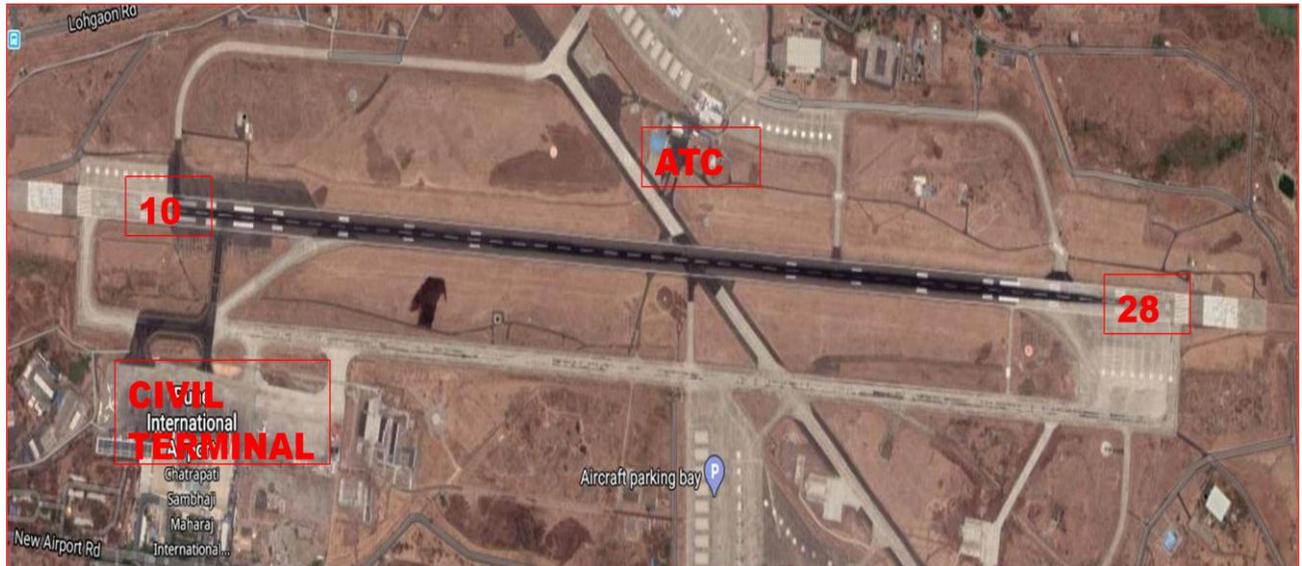


Fig 8: Satellite Image (Google) of Pune International Airport

1.11 Flight Recorders

The aircraft was fitted with Solid State Cockpit Voice Recorder having part No. 2100-1028-02 and Serial No. 002029015 and Digital Flight Data Recorder having part No. 2100-4043-02 and Serial No. 000167736.

1.11.1 *Relevant DFDR data*

The DFDR data from 02:35:00 UTC to 04:35:00 UTC were downloaded to have an overview of the whole flight. However, to have an overview of take off data, the data from 02:37:50 UTC to 02:39:30 UTC were analysed.

At 02:38:00 UTC, the aircraft was in the following configuration:-

Aircraft configuration on ground

- Gross weight was 77.3t < MTOW (89t).
- CG was 27.4%.

Note: CG parameter is computed by the Flight Augmentation Computer (FAC).

On ground, the CG value is the one entered in the MCDU.

- Aircraft was in Slats/Flaps configuration 1+F (18°/10°).
- Trimmable Horizontal Stabilizer (THS) position was -0.2°.
- Ground spoilers were armed.
- Autobrake "MAX" mode was armed.

Take-off Initiation

- Thrust levers were pushed to +9° (between "IDLE" and "MCL").
 - N1 increased from 20% to 50% within 10s.
- At 02:38:15 UTC, thrust levers were pushed to "FLEX" within 6s. FLEX temperature was +45°C.
- Both Flight Directors (FDs) were engaged in "SRS" (vertical) mode.
- Autothrust (A/THR) was armed.
- Based on Air India information (flight plan), take-off speeds V1/VR/V2 were 143kt / 147kt / 150kt for a take-off in CONF 1+F with FLEX thrust (FLEX temperature +45°C).
- Speed target was 150kt (V2 value)

Take-Off Roll and Tail Strike

(From 02:38:00 UTC to lift-off (02:38:53 UTC): Tail strike Occurred)

- During roll out, nose-down sidestick input was maintained by PF around a third of full deflection. Then, the sidestick was released at 02:38:37 UTC (CAS was around 100kt).
 - Aircraft pitch angle remained stable around +1°.
- At 02:38:44 UTC, CAS was 123kt and rotation was initiated by PF with a nose-up input up to full deflection progressively released to half of full deflection:
 - Pitch angle increased from +1 to +11.6°.
 - Pitch rate reached +4°/s.
 - Nose landing gear was recorded uncompressed.
 - Roll angle was -0.3° (left wing down) when pitch angle reached its maximum.
- At 02:38:49 UTC, CAS was 135kt and thrust levers were pushed to "TOGA".
 - N1 increased from 95% to 102%.
- At 02:38:50 UTC, pitch angle was +9.8° and the nose-up order applied by PF was increased up to full deflection:
 - Pitch angle re-increased up to +12° and remained stable at this value for 2s.
 - Pitch rate reached +2°/s.
 - Roll angle was -0.7° (left wing down) when pitch angle reached its maximum.

- At 02:38:52 UTC, CAS was 147kt when radio altimeters started to increase.

1.11.2 Cockpit Voice Recorder Analysis

Since the duration of flight from Pune to Delhi was of more than 2 Hrs, initial recording relevant to takeoff was not available. However, tape transcript obtained from Pune ATC was available for investigation purpose.

1.12 Wreckage and Impact Information

N/A

1.13 Medical and Pathological Information

The crew had undergone pre-flight medical (Breath Analyser Test) at Delhi before departure (Delhi – Pune sector) as per requirement of CAR Section 5, Series F, Part III. The test result was negative i.e. both cockpit crew were not under the influence of alcohol.

The crew had undergone post – flight medical test at Delhi after the incident which was found to be negative.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The incident was survivable.

1.16 Tests and Research

Nil

1.17 Organisational and Management Information

Air India Ltd is a scheduled airline with an Airbus fleet of 70 aircraft and 43 aircraft of Boeing fleet operating flights on domestic and international sectors. The Airline's Head Quarter is located at New Delhi. The Air Operator Permit of the Airlines is valid till 30/06/2023. The Company is headed by Chairman & Managing Director assisted by a team of professional of various departments. The Flight Safety Department is headed by Chief of Flight Safety approved by DGCA. The Chief of Safety is an Executive Director who reports directly to the Chairman.

M/s Air India has a fully established Operations training facility for pilots. The training facility for the Airbus pilots is set up at Hyderabad and for the Boeing pilots, it is in Mumbai. Both training facilities are headed by the Executive Director Training who reports to Chairman directly. The Engineering training facility is established at Delhi and Mumbai.

1.18 Additional Information

Load and Trim sheet for the incidented flight was prepared before the flight. Load and trim sheet as provided by the crew.

FROM/TO FLIGHT	A/C REG VERSION	CREW	DATE	TIME
PNQ DEL AI0852/15	VTPPU C12Y170	2/5	15FEB20	0155
LOAD IN CCMPARTMENTS		DISTRIBUTION		
PASSENGER/CABIN BAG	WEIGHT 3377 1/0 2/840	3/1537	4/1000	5/0 0/0
	13719 130/47/2/1	TTL 180 CAB 0		
	PAX 10/169			
TOTAL TRAFFIC LOAD	17096			
DRY OPERATING WEIGHT	49158			
ZERO FUEL WEIGHT ACTUAL	66254 MAX	71500	ADJ	
TAKE OFF FUEL	10800			
TAKE OFF WEIGHT ACTUAL	77054 MAX	81012	L	ADJ
TRIP FUEL	5512			
LANDING WEIGHT ACTUAL	71542 MAX	75500	L	ADJ
BALANCE AND SEATING CONDITIONS		LAST MINUTE CHANGES		
JI 38.39		DEST SPEC	CL/CPT + - WEIGHT	
LIEFW 62.39	MACZFW 29.47			
LITOW 57.20	MACTOW 27.24			
LILAW 57.15	MACLAW 27.40			
STAB TO 00.3				
SEATING				
OA/10 OB/81 OC/88				
UNDERLOAD BEFORE LMC	3958	LMC TOTAL + -		
LOADMESSAGE AND CAPTAINS INFORMATION BEFORE LMC				
***** ADC : M734 // FIC : 0226 *****				
THIS AIRCRAFT HAS BEEN LOADED IN ACCORDANCE WITH THE LOADING INSTRUCTIONS INCLUDING THE DEVIATIONS RECORDED. THE LOAD HAS BEEN SECURED IN ACCORDANCE WITH COMPANY REGULATIONS				
SIGNED				
NOTOC - NIL				
LDM AI0852/15.VTPPU.C12Y170.2/5 -DEL.130/47/2/1.O.T3377.2/840.3/1537.4/1000 .PAX/10/169.PAD/0/0 SI DEL B/2837.C/540.M/NIL.E/NIL				

Fig 9: Load and Trim Sheet of Flight AI852

1.19 Useful or Effective Investigation Techniques

Nil

2. ANALYSIS

2.1 Serviceability of the Aircraft

Aircraft VT-PPU (MSN- 04096) was manufactured in year 2009. The aircraft is registered with DGCA under the ownership of M/s Air India Limited. At the time of incident, the Certificate of Airworthiness was current and valid. On the day of incident, the aircraft VT-PPU had logged 31692:22 AF Hours (TSN) and 18140 Landings (CSN). VT-PPU was operated under Scheduled Operator's Permit No S-9 which was valid. The aircraft and engines were being maintained under continuous maintenance as per maintenance program consisting of calendar period based maintenance and flying Hours/ Cycles based maintenance as per maintenance program approved DGCA. Accordingly, the major and all lower inspections (Pre-flight checks, Service Checks, Weekly Checks) were carried out as and when due.

The left Engine S/N 697888 had logged 33068:01 EHrs / 20658 ECYC and the right Engine S/N 697831 had logged 30046:04 EHrs / 19572 ECYC. There was no defect reported on the previous flight. All concerned Airworthiness Directives, mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engines had been complied with as on date of event.

The defect record of the aircraft were scrutinized for a period of one month prior to the date of occurrence of the serious incident and no defect was found pending on the aircraft. Prior to the incident flight, the weight and balance of the aircraft was well within the operating limits. From the above, ***it is inferred that the serviceability of the aircraft is not a contributory factor to the incident.***

2.2 Weather

The visibility at the time of takeoff at Pune was 3000 meter (Haze), Winds variable/02 knots and temperature 19.8 degree C with no significant change in the prevailing weather conditions. Hence, aircraft did not encounter any adverse weather condition during takeoff. ***Weather is not a contributory factor to the incident.***

2.3 Air Traffic Controller

The air traffic controller involved in this occurrence held a valid air traffic controller licence with the appropriate rating.

2.4 Analysis of Digital Flight Data Recorder

(a) The DFDR recordings and analysis revealed that weight and CG of the aircraft were in accordance with the "Load and Trim" sheet provided by crew. Further, aircraft CG of 27.4% corresponding to a takeoff trim setting of -0.2° (nose up) by crew was in accordance with the QRH (extract as shown in Fig -10). The stabilizer trim value at take-off was thus consistent with the CG entered in MCDU.

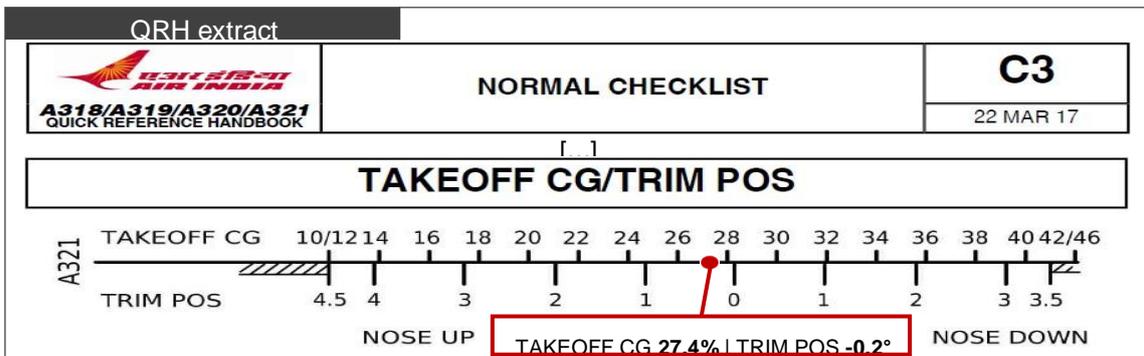


Fig 10: QRH Extract: QRH C3 Takeoff CG/Trim POS

(b) **Re-Computation of Takeoff Speeds:** Re-computation of take-off speeds as provided by crew to the investigation team was undertaken with assistance of OEM and it was confirmed that the computed take-off speeds by crew were correct. Hence, it is concluded that **there was no discrepancy in CG, trim or take-off speed as computed by crew for the flight.**

Operating speeds	Values
V ₁ IAS	143kt
V _R IAS	147kt
V ₂ IAS	150kt

Fig 11 – Recomputed take-off speeds by OEM (Airbus)

(c) Takeoff Roll and Tail Strike (On the longitudinal Axis)

As per DFDR analysis, at 02:38:37 UTC, as per SOP, the nose-down order applied by PF was released at around 100kts of CAS. There was no early autorotation when the nose-down input was released, confirming that the take-off pitch trim setting was correct.

Then 7 sec later, at a CAS of 123kt corresponding to V_R -24kts, rotation was initiated by PF with a back stick input up to full deflection (1 - Fig-12 refers) leading the pitch angle to increase with a pitch rate reaching $+4^\circ/s$.

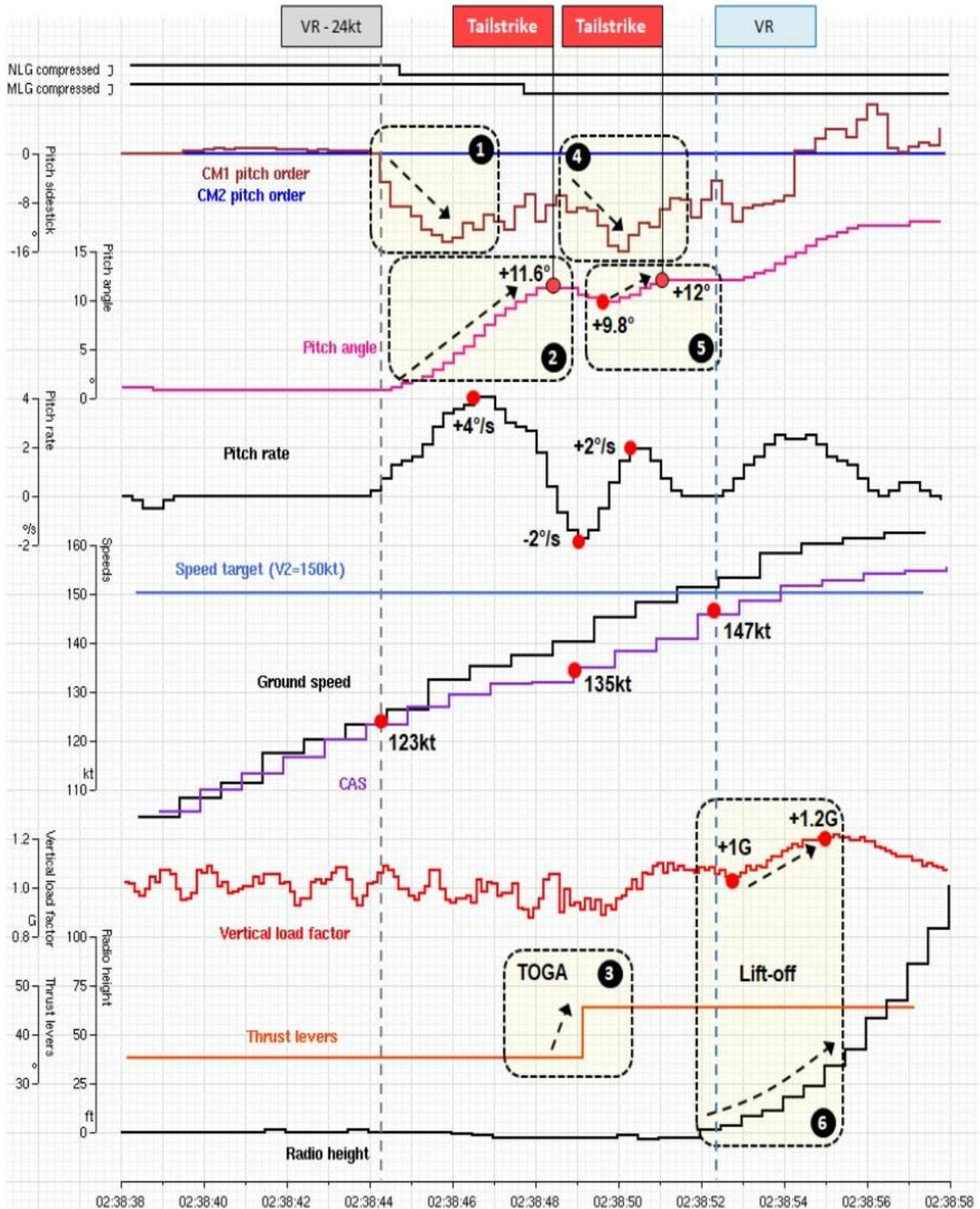


Figure 12 – Take-off analysis

At 02:38:48 UTC, pitch angle reached +11.6° with a roll angle of -0.3° (left wing down), the first tail strike occurred (2 - Fig-12 refers). Simultaneously, nose-down effect due to the contact of the rear fuselage with the ground (due to tail strike) led the pitch angle to decrease to +9.8° with a pitch rate reaching -2°/s.

At 02:38:49 UTC, CAS was 135kt (VR-12kt) when thrust levers were pushed from "FLEX" to "TOGA" leading the thrust to increase (3- Fig-12 refers). One second later, the nose-up order applied by PF was increased to full deflection (4- Fig-12 refers) leading the pitch angle to increase again with a pitch rate reaching +2°/s. Further, at 02:38:51 UTC, pitch angle reached +12° with a roll angle of -0.7° and; the rear fuselage entered into contact with the ground when the pitch angle is +11.4°: a second tail strike occurred (5- Fig-12 refers).

As per FCTM (Fig- 13 refers), in normal conditions, the rotation should be performed at VR. However, when rotation is initiated below scheduled VR, an early rotation occurs. And whatever the cause of the early rotation, the result will be an increased pitch attitude at lift-off and consequently a reduced tail clearance.

FCTM extract	
 A318/A319/A320/A321 FLIGHT CREW TECHNIQUES MANUAL	PROCEDURES NORMAL PROCEDURES STANDARD OPERATING PROCEDURES - TAKEOFF
TAIL STRIKE AVOIDANCE	
<u>MAIN FACTORS</u>	
EARLY ROTATION	
Early rotation occurs when rotation is initiated below the scheduled VR. The potential reasons for this are:	
<ul style="list-style-type: none"> • The calculated VR is incorrect for the aircraft weight or flap configuration. • The PF commands rotation below VR due to gusts, windshear or an obstacle on the runway. 	
<u>Whatever the cause of the early rotation, the result will be an increased pitch attitude at liftoff, and consequently a reduced tail clearance.</u>	

Fig – 13: Extract of FCTM - PR-NP-SOP-120 TAILSTRIKE AVOIDANCE

At 02:38:52 UTC, CAS of 147kts (VR) was achieved and the vertical load factor started to increase from +1.0G to +1.2G. Further, Radio altimeters reading started to increase and finally the aircraft was lifting-off (6- Fig-12 refers).

One second later at 02:38:53 UTC, the nose-up sidestick input applied by PF was released and some nose-down orders were applied up to half of full deflection, leading the pitch angle to continue to increase upto +18°, then it was stabilized around +15°. The aircraft kept on lifting and set course to destination.

2.5 Analysis of Tape Transcript

The crew and controller were in positive communication. After obtaining take off clearance from ATC, aircraft initiated take off roll. After 04 seconds of initiation of take off roll, PIC noticed a vehicle on the runway. The pilot initiated early rotation to avoid collision with the vehicle. It is pertinent to note that Pune runway has a slope almost at centre of the runway. Hence, PIC could not notice the vehicle on the runway, till aircraft reached top of the slope. The PIC immediately informed the ATC about the presence of vehicle on runway and the same was acknowledged by the ATC.

Hence, ATC handling of the Aircraft was contributory factor to the incident.

2.6 Operational Factor

2.6.1 Pilot Factor

Both cockpit crew were qualified to operate the flight. The PIC was holding valid ATPL license and the FO was holding a valid CPL license and were qualified on type. Both crew were current in all trainings and ratings as per the requirements. All actions taken by cockpit crew were in accordance to Flight Crew Training Manual (FCTM).

The Captain had total flying experience of about 7090 hours with approximately 3670 hours on type and about 1670 hours as PIC on type. The co-pilot had a total flying experience of about 2115:45 hours with approximately 1921:11 hours on type.

2.6.2 Crew Handling of the Aircraft and Decision Making

Pilot-in-Command discretion decided to continue the flight on to Delhi Airport after having reviewed all relevant aspects as mentioned below:-

- (i) No abnormality was noticed by PIC, CP and the passengers. However, one of the cabin crew seating at AFT galley had experienced a jerk in the tail momentarily while aircraft was taking off.
- (ii) All parameters related to pressurisation were normal.

- (iii) The aircraft had sufficient fuel remaining.
- (iv) The weather at expected time of arrival at Delhi Airport (destination) was favourable.

As per DFDR and available recording in SSCVR, all associated checks were carried out as per the SOP by crew.

2.6.3. ATC Handling

On 15 Feb 2020, After due clearance from runway controller Bird Controller Vehicle entered runway 28 to inspect the runway for presence of bird remains and any other foreign objects. Meanwhile, aircraft VT-PPU was preparing for takeoff from runway 10. ATC accorded take off clearance to VT-PPU, but while doing so overlooked the fact that the Bird Controller Vehicle was still on the beginning of runway 28. The vehicle had stopped at a distance of 50 mtrs from runway 28 to pick up some FOD lying on the runway. The moment runway controller stationed at runway 28 saw the aircraft; he immediately instructed the vehicle to vacate the runway. At that point of time, aircraft VT-PPU was near middle marker and on top of the runway slope. The distance between the aircraft and stationary vehicle standing on the edge of runway was more than 1000 mtrs. It is pertinent to note that complete runway is visible from the tower and aircraft was permitted to line up on Rwy 10 by the controller. The aircraft was given takeoff clearance by runway controller without realising presence of obstacle on runway.

2.7 Circumstances Leading to the Incident

Due to lack of situational awareness, the controller gave the take off clearance to the aircraft without realizing that a vehicle is already on the runway,. The aircraft after obtaining clearance from ATC, lined up for takeoff and commenced take off role. As the runway has a slope till almost centre of the runway, the PIC noticed a vehicle only after aircraft attained CAS of 123 kts and on reaching top of the slope. PIC initiated rotation by applying back stick input to full deflection. At this point, aircraft tail scrapped the runway surface. At this juncture, the pitch of the aircraft reduced. Thereafter, PIC applied TOGA, aircraft ground speed kept on increasing and the pitch of the aircraft also increased to 12 degrees. At this time, aircraft tail touched (Striked) the runway surface second time. The ground speed kept on increasing and at ground speed 147 kts, the aircraft lifted off.

3. CONCLUSION

3.1 Findings

- (a) The Certificate of Airworthiness, Certificate of Registration and Certificate of Flight Release of the Aircraft were valid on the day of Incident.
- (b) All concerned airworthiness directives, mandatory service bulletins, mandatory modifications on the aircraft and its engines on date of incident had been complied with.
- (c) Both operating crew were duly qualified on type to operate the flight.
- (d) As per Flight Duty Time Limitations (FDTL), both crew had adequate rest prior to undertaking the flight on 15 Feb 2020.
- (e) Visibility at the time of occurrence was 3 kms.
- (f) There was no snag reported prior to the incidented flight.
- (g) The taxi out was uneventful.
- (h) There was a vehicle on the runway.
- (j) The crew were forced to initiate rotation early.
- (k) The crew set the TOGA thrust accordingly.
- (l) As per DFDR data, aircraft tail struck the runway twice.
- (m) Flight crew suspected tail strike and confirmed the same with cabin crew and ATC.
- (n) No visual marks or debris were found on the runway during inspection by ATC
- (o) Nothing unusual was reported / noticed during the entire operation of flight.
- (p) There were No abnormalities after take-off, or warnings generated in the cockpit, hence PIC used his discretion and the flight was continued to its destination.
- (q) Tail strike marks were observed by PIC after landing at destination, while carrying out external checks after parking.
- (r) ATC reported no sign of tail strike on runway.
- (p) Vehicle and person were on the runway during takeoff role.
- (s) ATCO lost the situational awareness and gave takeoff clearance.
- (r) Runway End (Rwy 28) is not visible from runway 10 threshold as there is a slope almost till the middle of the runway.
- (t) Both ends of runway are visible from ATC tower.
- (u) All parameters of aircraft were normal during entire duration of flight till destination
- (v) The Flight to destination was uneventful and aircraft landed safely at Delhi.
- (x) No injury to any personnel or property was reported.

3.2 Probable Cause of the Incident

The cause for tail strike was the presence of a vehicle on the runway, which led to the flight crew having prematurely rotate the aircraft before attaining Vr.

4. SAFETY RECOMMENDATIONS

- (a) IAF may revisit their SOP to obviate such occurrences in future.
- (b) IAF may impart suitable continuity training to involved controller.



(Kunj Lata)
Asst Director
AAIB
Investigator



(Anil Tewari)
Director
AAIB
Investigator – In - Charge

Date: 09 Dec 2020
Place: New Delhi