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**FINAL INVESTIGATION REPORT**

**ON**

**SERIOUS INCIDENT TO M/S AIR INDIA EXPRESS LTD.**

**BOEING 737-800 AIRCRAFT VT-AYA**

**AT MANGALORE ON 30<sup>TH</sup> JUNE 2019.**

**Kunj Lata  
Investigator**

**Capt. Priti Kohal  
Investigator**

**K. Ramachandran  
Investigator -In- charge**

## **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 the 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.*

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## GLOSSARY

AAIB	Aircraft Accident Investigation Bureau, India
AGL	Above Ground Level
AMSL	Above Mean Sea Level
ARC	Airworthiness Review Certificate
ATC	Air Traffic Control
ATPL	Airline Transport Pilot License
AUW	All Up Weight
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CAR	Civil Aviation Requirements
CPL	Commercial Pilot License
DGCA	Directorate General of Civil Aviation
DME	Distance Measuring Equipment
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
FRTOL	Flight Radio Telephone Operators License
HAT	Height Above Threshold
hrs	Hours
IFR	Instrument Flying 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
PIC	Pilot in Command
QRH	Quick Reference Handbook
RA	Radio Altitude
RESA	Runway End Safety Area
ROD	Rate of Descent
TOGA	Take-Off Go-Around
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Range
UTC	Coordinated Universal Time

**FINAL INVESTIGATION REPORT ON SERIOUS ACCIDENT TO M/S AIR INDIA  
EXPRESS LIMITED B737-800 AIRCRAFT VT-AYA AT MANGALORE ON 30<sup>th</sup> JUNE  
2019.**

1.	Aircraft	Type	B737-800
		Nationality	Indian
		Registration	VT-AYA
2.	Owner & Operator		Air India Express Limited
3.	Pilot		ATPL Holder
	Extent of Injuries		Nil
4.	Co- Pilot		CPL Holder
	Extent of Injuries		Nil
5.	No. of Passengers on board		183
6.	Date & Time of Serious Incident		30 <sup>th</sup> June 2019 at 1212 UTC
7.	Place of Serious Incident		Mangalore Airport
8.	Co-ordinates of Serious Incident Site, AMSL		Lat: 12°56'57.96" N Long: 74°52'30.34" E.
9.	Last point of Departure		Dubai Airport
10.	Intended landing place		Mangalore Airport
11.	Type of Operation		Scheduled Operation
12.	Phase of operation		Landing Roll
13.	Type of Serious Incident		Runway Excursion

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

## **SYNOPSIS**

On 30<sup>th</sup> June 2019, M/s Air India Express Ltd. Boeing B737-800 aircraft VT-AYA while operating a scheduled flight from Dubai to Mangalore was involved in a Serious Incident of “runway excursion” while landing at Mangalore airport.

The aircraft was under the command of an ATPL holder who was Pilot Flying (PF) with a co-pilot a CPL holder who was Pilot Monitoring (PM). There were 183 passengers and 04 cabin crew members on board the aircraft.

The aircraft took-off from Dubai airport and the en-route flight was uneventful. The Mangalore, ATC vectored the aircraft and gave landing clearance for ILS runway 24. At 500 ft. AGL, the airspeed decreased, and a GPWS “Glideslope” Warning came in the cockpit and the PIC immediately carried out a “go around”.

ATC provided radar vectors for another ILS approach runway 24 from the north and gave landing clearance. The aircraft was high on final approach below minimums and made a delayed touch down at about 900 meters ahead of runway 24 threshold. After the touchdown, the crew applied brakes but the aircraft didn't stop within the runway 24 end. As the end of runway was approaching, the PF turned the aircraft to the right to avoid exiting from runway end. However, as the speed of the aircraft was high, the aircraft left the unpaved surface from taxiway 'E' intersection. The aircraft came to its final halt on the unpaved surface at a distance of about 80 m from runway edge.

Director General, AAIB appointed Sh. K Ramachandran, Assistant Director, AAIB as Investigator – In – Charge with Ms. Kunj Lata, Assistant Director, AAIB and Capt. Priti Kohal as Investigators to investigate into the probable cause(s) of the serious incident, vide Order No. INV.12011/12/2019-AAIB dated 1<sup>st</sup> July 2019 under Rule 11 (1) of Aircraft (Investigation of Accidents and Incidents), Rules 2017.

# **1 FACTUAL INFORMATION**

## **1.1 HISTORY OF THE FLIGHT**

On the day of incident prior to the incidented flight, the aircraft had operated sector Mangalore to Dubai. There was no abnormality reported on the aircraft. Thereafter, the aircraft was scheduled to operate sector Dubai - Mangalore. The Pilot – In – Command who was Pilot Flying and Co-Pilot who was Pilot Monitoring (PM) were paired together for the first time to operate these flights.

The aircraft took-off from Dubai at 0915 UTC. The en-route flight for Mangalore was uneventful. The aircraft came in contact with Mangalore ATC (Approach) at 1140 UTC. Initially, the crew planned for an ILS DME approach runway 24 via 13 DME arc via radial 287 MML (VOR Nomenclature at Mangalore). However, crew observed lot of clouds over 15 DME and accordingly informed Approach ATC and asked to confirm heading. The Approach ATC confirmed with crew if they can do the ILS approach runway 24 via MML which the crew affirmed. The Approach ATC then vectored the aircraft for ILS approach runway 24. The aircraft was then changed over to Mangalore Tower. At 115923 UTC, the aircraft came in contact with Mangalore Tower. At 115929 UTC, the tower gave landing clearance to the aircraft and informed that winds are 270°/12 kts. The crew planned for flap 40 landing and carried out landing checklist. After establishing visual contact with runway, the PIC disconnected autopilot and auto-throttle at 745 feet AGL and started flying manually.

As per the statement of crew, because of strong winds the aircraft started deviating from localizer and glideslope but was within limits so they continued approach. However, at about 500 feet AGL, sudden downdraft (sink) was felt by the crew which was followed by GPWS warning of “Glideslope” in cockpit. The PIC decided to “Go Around” and immediately called out “Go Around” and pressed TOGA. The co-pilot informed ATC that they are going around. The ATC tower then asked crew to change over to Approach ATC. The crew informed approach that they are going around due to un-stabilized approach and requested for another approach in bound runway 24. The Approach ATC again vectored the aircraft for ILS approach runway 24. When the aircraft established (on localizer) ILS runway 24, it was cleared for ILS approach runway 24 at 120755 UTC. At 120837 UTC, the aircraft again came in contact with ATC tower. At 120901 UTC, the ATC tower gave clearance for landing on runway 24 and informed winds as 020°/07 knots. The ATC tower also informed that end of runway 24 is wet. The crew stated that, during second approach

the clouds came closer to the airport and they were able to sight the runway only at around 800 feet AGL. The autopilot was disconnected at around 500 feet and the PIC started flying manually. The speed of the aircraft started decreasing and was below Vapp (143 knots) when the co-pilot called out “Speed”. The captain said “Correcting” and increased thrust to overcome the same. The aircraft was high and was not stabilized during the final approach. The crew saw 4 whites on PAPI and the co-pilot called out for “Go Around”. However, the PIC continued approach and the aircraft made a delayed touchdown well ahead of the touchdown zone. As the thrust reversers were not deployed immediately after touchdown, so the co-pilot gave call out for “Reversers” and the same was deployed by the PIC. The crew did not select “Autobrakes” for landing and applied maximum manual braking and applied maximum pressure to stop the aircraft. However, the aircraft did not stop and at end of runway 24, the PIC suddenly turned the aircraft towards right of the runway just before taxiway ‘E’ intersection. The aircraft entered the unpaved surface from “Taxiway E” intersection and came to its final halt at around 80 meters from the runway edge.

The crew informed ATC that they are out of runway and asked ATC for assistance for normal disembarkation of passengers. The passengers were disembarked normally from “R1 door”. The aircraft sustained minor damages during the incident and there was no injury to any of the occupant on board the aircraft. There was no fire.

## 1.2 INJURIES TO PERSONS

<b>Injuries</b>	<b>Crew</b>	<b>Passengers</b>	<b>Others</b>
<b>Fatal</b>	NIL	NIL	NIL
<b>Serious</b>	NIL	NIL	NIL
<b>Minor/ None</b>	02+04	183	

## 1.3 DAMAGE TO AIRCRAFT

The aircraft sustained minor damages during the incident. The damages are given below:-

1. Minor damages were found at aft end of NLG (Nose Landing Gear) left side door bottom edge.





***Pic 1: Damage on NLG left door***

2. Both left and right fan cowls of LH engine were found damaged.



***Pic 2: Damaged LH Engine Cowl.***

3. On LH Engine, forward frame of both LH and RH Core Cowls (Thrust Reverser Cowls) were found damaged.

4. Cut marks were observed on the MLG (Main Landing Gear) tyres.



***Pic 3: Cut marks on MLG tyre.***

## 1.4 OTHER DAMAGE

One of the runway edge light near taxiway E intersection was found damaged.

## 1.5 PERSONNEL INFORMATION

### 1.5.1 Pilot – In – Command

Date of Birth & Sex	: 16.05.1979/Male
License	: ATPL
Date of Issue	: 27.08.2014
Valid up to	: 26.08.2021
Category	: Aeroplane (ME)
Date of Class I Med. Exam.	: 12.09.2018
Class I Medical Valid up to	: 11.09.2019
Date of issue FRTOL License	: 04.04.2017
FRTOL License Valid up to	: 03.04.2022
Endorsements as PIC	: B 737-800
Total flying experience	: 5500 hrs
Total flying experience on type	: 3000 hrs
Last Flown on type	: 30.06.2019
Total flying experience during last 1 year	: 737:09 hrs
Total flying experience during last 6 Months	: 396:50 hrs
Total flying experience during last 30 days	: 78:48 hrs
Total flying experience during last 07 Days	: 15:00 hrs
Total flying experience during last 24 Hours	: 15:00 hrs
Rest period before flight	: 13:30 hrs
Whether involved in Accident/Incident earlier	: Yes, involved in incident
Date of latest Flight Checks and Ground Classes:	: 04.08.2018 & 27.08.2018.

The PIC was the pilot flying. He joined the company in the year 2009. He had operated into Mangalore earlier. He was involved in an incident of altitude burst in March 2017.

### 1.15.2 Co-Pilot

Date of Birth	: 30.06.1992
License	: CPL
Date of Issue	: 21.08.2015

Valid up to	: 20.08.2020
Category	: AEROPLANE (ME)
Date of Class I Med. Exam.	: 15.11.2018
Class I Medical Valid up to	: 15.11.2019
Date of issue FRTOL License	: 21.08.2015
FRTOL License Valid up to	: 20.08.2020
Endorsements as PIC	: NA
Total flying experience	: 796:41 hrs
Total flying experience on type	: 583:41 hrs
Last Flown on type	: 30.06.2019
Total flying experience during last 1 year	: 583:41 hrs
Total flying experience during last 6 Months	: 379:38 hrs
Total flying experience during last 30 days	: 79:06 hrs
Total flying experience during last 07 Days	: 19:31 hrs
Total flying experience during last 24 Hours	: 07:44 hrs
Rest period before flight	: 30:00 hrs
Whether involved in Accident/Incident earlier	: No
Date of latest Flight Checks and Ground Classes	: 12.11.2018 & 11.03.2019

The co-pilot was the Pilot Monitoring. He joined the company in February 2018 and started flying as co-pilot from December 2018. He was based in Mangalore. Co-pilot was not involved in Accident/serious incident earlier.

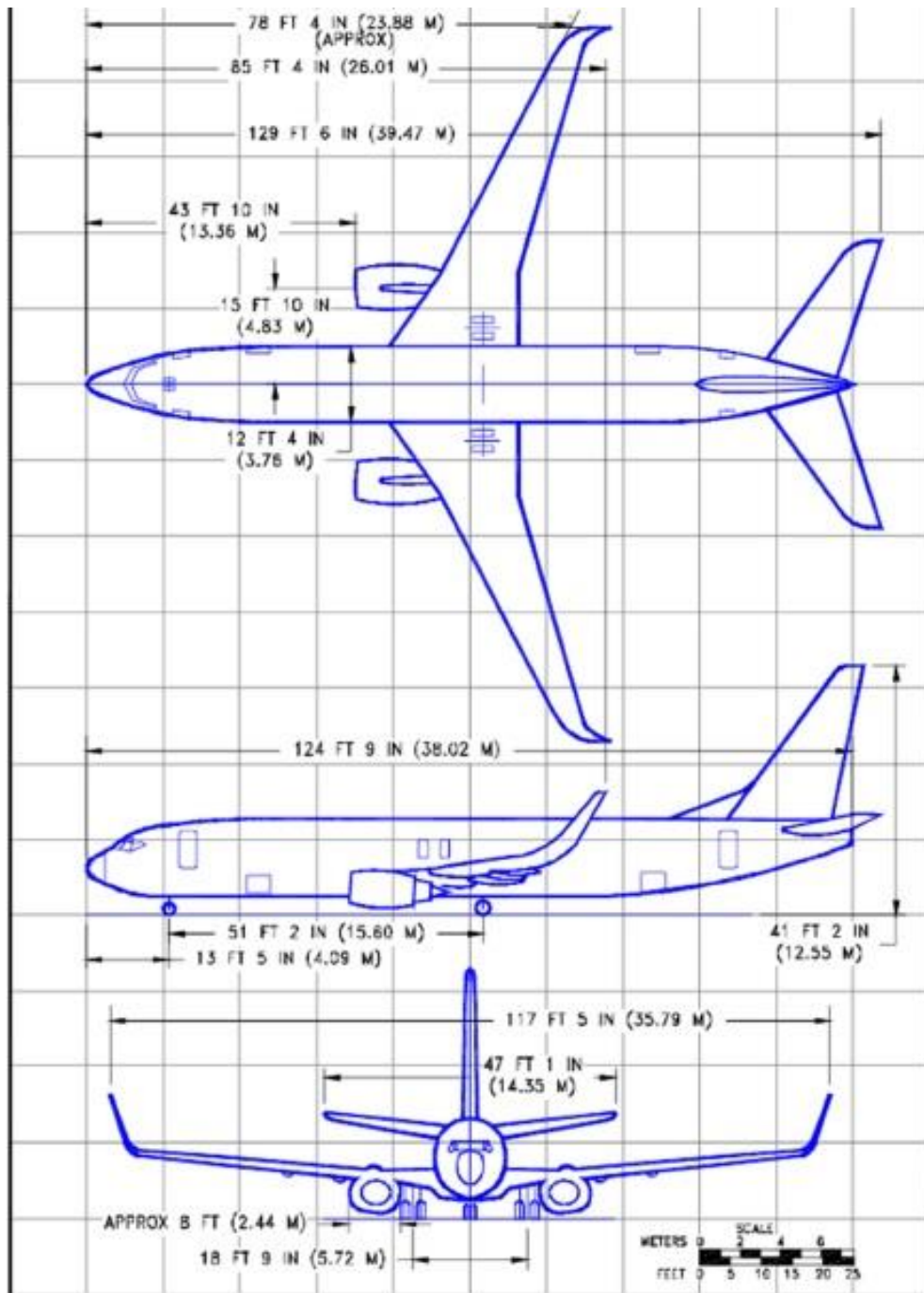
Both crew were paired for the first time.

## **1.6 AIRCRAFT INFORMATION**

### **1.6.1 Boeing 737-800 Aircraft Description**

Boeing B737-800 is a subsonic, medium-range, civil transport aircraft. The aircraft is installed with two high bypass turbofan engines manufactured by International Aero Engines. The aircraft is designed for operation with two pilots and has passenger seating capacity of 189. The aircraft is certified in Normal (Passenger) category, for day and night operation under VFR & IFR. The maximum take-off weight is 79015 Kgs. The Maximum Landing weight is 65317 Kgs.

The Aircraft length is 39.472 meters, wingspan is 35.8 meters and height is 12.459 meters. The distance between main wheel centers is 5.715 meters. The Ground Clearance is 0.53 meters.



*Pic 4: Three View diagram of Boeing 737-800 aircraft*

### 1.6.1.1 Brake System

For the purposes of operation of various systems and controls including brakes, there are three hydraulic systems viz main, alternate and standby. The standby system can be used in emergency, if main and alternate system pressure is lost.

Either main or alternate hydraulic system can power all flight controls with no decrease in aircraft controllability.

Each main gear wheel has a multi-disc hydraulic powered brake. The brake pedals provide independent control of the left and right brakes. The nose wheels have no brakes. The normal brake system is powered by main hydraulic system and the alternate brake system is powered by alternate hydraulic system. If main hydraulic system is low or fails, alternate hydraulic system automatically supplies pressure to the alternate brake system. The brake accumulator is pressurized by main hydraulic system. If both normal and alternate brake system pressure is lost, trapped hydraulic pressure in the brake accumulator can still provide several braking applications or parking brake application.

The autobrake system uses main hydraulic system pressure to provide maximum deceleration for rejected takeoff and automatic braking at preselected deceleration rates immediately after touchdown. The system operates only when the normal brake system is functioning.

Antiskid protection is provided in the normal and alternate brake systems. The normal brake hydraulic system provides each main gear wheel with individual antiskid protection. When the system detects a skid, the associated antiskid valve reduces brake pressure until skidding stops. The alternate brake hydraulic system works similar to the normal system however antiskid protection is applied to main gear wheel pairs instead of individual wheels. Both normal and alternate brake systems provide skid, locked wheel, touch-down and aquaplane protection. Antiskid protection is provided during autobrake operation and is available even with loss of both hydraulic systems.

## **1.6.2 Aircraft VT-AYA General Information**

Aircraft Model	: Boeing 737-800 NG
Aircraft S. No.	: 36337
Year of Manufacturer	: 2009
Name of Owner	:M/s Four Lions Aircraft LLC.
C of R	: Certificate No.3944/2
C of A	: No.6053
Category	: A

C of A Validity	: Life time
A R C issued on	: 04.04.2019
ARC valid up to	: 05.04.2020
Aircraft Empty Weight	: 41580.32 Kgs
Maximum Take-off weight	: 79015 kgs
Date of Aircraft weighment	: 01.02.2019
Empty Weight	: 41580.32 Kgs
Max Usable Fuel	: 21340.17 kgs
Max Pay load with full fuel	: 15072.31 kgs
Empty Weight C.G	: 660.37 inches
Next Weighing due	: 01.02.2024
Total Aircraft Hours	: 34936
Last major inspection	: Phase check-78 (at TSN 34871 / CSN 11823)
Engine Type	: CFM 56-7B
Date of Manufacture LH	: 2007
Engine Sl. No. LH	: 894732
Last major inspection (LH)	: Phase check-78
Total Engine Hours/Cycles LH	: 35101 & 12386
Date of Manufacture RH	: 2007
Engine Sl. No. RH	: 894401
Last major inspection (RH)	: Phase check-78
Total Engine Hours/Cycles RH	: 38599 & 13670
Aero mobile License No.	: A-016/003/WRL-09

All concerned Airworthiness Directives, mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine have been complied with as on date of event. Scrutiny of the Technical Log Book revealed that, there was no snag pending on the aircraft prior to the incidented flight. The last snag recorded was on 27<sup>th</sup> June 2019 and the snag was “Just before push back, crew reported that after pressurization, brake pressure showed 2200 psi”. The rectification action was carried out satisfactorily and the aircraft was released for further flights.

Load and trim sheet of the incidented flight was prepared and center of gravity was found within limit.

## 1.7 METEOROLOGICAL INFORMATION

MET Report – Mangalore Airport from 1130 UTC to 1230 UTC.

Time in UTC	Wind Dir	Wind Speed (KT)	Vis (m)	Temp (°C)	Dew Point	QFE hPa	QNH hPa	TREND
1130	280	08	6000	29	24	994	1006	No SIG
1200	270	10	6000	29	24	994	1006	TEMPO Vis 4000 m - RA
1230	360	07	6000	27	24	995	1007	TEMPO Vis 4000 m - RA

## 1.8 AIDS TO NAVIGATION

Mangalore airport is equipped with ILS approach on Runway 24 and VOR DME approach on Runway 06. ILS localizer has a frequency of 110.1MHz. Other Navigational Aids are DVOR, DME (Distance Measuring Equipment), NDB (Non-Directional Beacon) MSSR (Monopulse Secondary Surveillance Radar). All navigational aids were in serviceable condition.

## 1.9 COMMUNICATIONS

At the time of incident, the aircraft was in contact with Mangalore Tower on frequency 122.1 MHz. There was always two-way communication between the aircraft & ATC.

Following are some salient transcripts of ATC tape: -

### APPROACH, 125.05 MHz

Time	Station To	Station From	Transcript
11:40:00	APPROACH	AXB384	MANGALORE APPROACH AXB384 (----- -) NOT CLEAR
11:41:05	AXB384	APPROACH	AXB384 APPROACH RADAR CONTACT CONTINUE DESCEND TO 7000 FEET TRANSITION LEVEL FL105 QNH 1006
11:44:23	APPROACH	AXB384	AXB384 CONFIRM HEADING WE CAN SEE WEATHER OVER 15 DME FIX
11:44:35	AXB384	APPROACH	AXB384 CONFIRM UNABLE TO TAKE LEFT HEADING
11:44:39	APPROACH	AXB384	AFFIRM AXB384
11:44:41	AXB384	APPROACH	ROGER CONFIRM LIKE TO DO THE ILS APPROACH RWY 24 VIA MML
11:44:49	APPROACH	AXB384	AFFIRM WE CAN DO

11:44:50	AXB384	APPROACH	ROGER EXPECT ILS APPROACH RWY 24 VIA MML
11:44:55	APPROACH	AXB384	ILS APPROACH RWY 24 VIA MML AXB384
11:52:52	APPROACH	AXB384	AXB384 STATUS OVER THE AIRFIELD
11:52:58	AXB384	APPROACH	NO RAIN RWY DRY
11:53:01	APPROACH	AXB384	CONFIRM DRY
11:53:02	AXB384	APPROACH	AXB384 CORRECT
11:53:04	APPROACH	AXB384	THANK YOU SIR
11:54:59	AXB384	APPROACH	AXB384 REDUCE SPEED TO 180 KNOTS
11:55:03	APPROACH	AXB384	REDUCE SPEED TO 180 KNOTS AXB384
11:56:31	AXB384	APPROACH	AXB384 FOR INFORMATION TO THE RIGHT MINIMUM VECTORING ALTITUDE IS 6100 FEET
11:56:41	APPROACH	AXB384	COPIED AXB384
11:57:18	AXB384	APPROACH	AXB384 CLEARED FOR ILS APPROACH RWY 24
11:57:21	APPROACH	AXB384	CLEARED FOR ILS APPROACH RWY 24 AXB384
11:58:05	APPROACH	AXB384	WE ARE ON LOCALIZER AXB384 FOR RWY24
11:58:10	AXB384	APPROACH	AXB384 ROGER
11:59:07	APPROACH	AXB384	APPROACH AXB384 ON ILS RWY 24
11:59:12	AXB384	APPROACH	AXB384 6 ½ MILES FROM TOUCHDOWN CONTACT TOWER 122.1
11:59:16	APPROACH	AXB384	TOWER 122.1 AXB384
<b>TOWER, 122.1 MHz</b>			
<b>Time</b>	<b>Station To</b>	<b>Station From</b>	<b>Transcript</b>
11:59:23	TWR	AXB384	MANGALORE TWR AXB384 ON ILS RWY 24 GOOD EVENING
11:59:29	AXB384	TWR	AXB384 MANGALORE TWR GOOD EVENING SIR RWY24 CLEARED TO LAND WIND 270 DEGREES 12 KNOTS
11:59:34	TWR	AXB384	RWY24 CLEARED TO LAND AXB384
12:01:35	TWR	AXB384	TWR AXB384 GOING AROUND
12:01:37	AXB384	TWR	AXB384 TWR ROGER
12:02:09	AXB384	TWR	AXB384 TWR CONTACT APPROACH 125.05
12:02:13	TWR	AXB384	125.05 AXB384 GOOD DAY
<b>APPROACH, 125.05 MHz</b>			
<b>Time</b>	<b>Station To</b>	<b>Station From</b>	<b>Transcript</b>
12:02:44	APPROACH	AXB384	APPROACH AXB384 GOING AROUND CLIMBING PASSING 2400
12:02:53	AXB384	APPROACH	AXB384 ROGER IDENTIFIED REPORT INTENTION



12:02:59	APPROACH	AXB384	UNSTABILIZED APPROACH AXB384 WOULD LIKE TO GET RADAR VECTORS FOR MML
12:03:09	AXB384	APPROACH	AXB384 ROGER CONFIRM WOULD LIKE TO DO ONE MORE APPROACH NOW
12:03:15	APPROACH	AXB384	AFFIRM AXB384
12:06:07	AXB384	APPROACH	AXB384 WIND NOW 010 DEGREES 08 KNOTS
12:06:15	APPROACH	AXB384	COPIED AXB384
12:07:00	AXB384	APPROACH	AXB384 FOR INFORMATION WEATHER APPROACHING FROM SOUTH WEST
12:07:08	APPROACH	AXB384	CONFIRM RUNWAY IS WET
12:07:10	AXB384	APPROACH	AXB384 TURN RIGHT HEADING 210 TO INTERCEPT FINAL APPROACH TRACK RWY 24 REPORT ESTABLISHED
12:07:16	APPROACH	AXB384	TURN RIGHT HEADING 240 TO INTERCEPT FINAL APPROACH TRACK RWY 24 ON ILS AXB384 CALL YOU ESTABLISHED
12:07:45	APPROACH	AXB384	ON LOCALIZER ILS RWY 24 AXB384
12:07:50	AXB384	APPROACH	AXB384 ROGER CONTINUE APPROACH
12:07:53	APPROACH	AXB384	CONTINUE APPROACH AXB384
12:07:55	AXB384	APPROACH	AXB384 CLEARED FOR ILS APPROACH RWY 24
12:07:58	APPROACH	AXB384	CLEARED FOR ILS APPROACH RWY 24 AXB384
12:08:24	AXB384	APPROACH	AXB384 8 ½ MILES FROM TOUCHDOWN CONTACT TOWER 122.1
12:08:29	APPROACH	AXB384	TOWER 122.1 GOOD DAY
12:08:32	AXB384	APPROACH	GOOD DAY
<b>TOWER, 122.1 MHz</b>			
<b>Time</b>	<b>Station To</b>	<b>Station From</b>	<b>Transcript</b>
12:08:37	TWR	AXB384	MANGALORE TOWER AXB384 ON LOCALIZER RUNdWAY 24
12:08:42	AXB384	TWR	AXB384 TWR ROGER REPORT ILS RUNWAY 24
12:08:45	TWR	AXB384	CALL YOU ON ILS RUNWAY 24 AXB384
12:08:47	AXB384	TWR	AXB384 TWR CAUTION END OF THE RUNWAY 24 IS WET
12:08:52	TWR	AXB384	ROGER AXB384
12:08:57	TWR	AXB384	ON ILS RUNWAY24 AXB384
12:09:01	TWR	AXB384	AXB384 TWR ROGER RUNWAY 24 CLEARED TO LAND WIND 020 DEGREES 07 KNOTS
12:09:09	AXB384	TWR	CLEARED TO LAND RUNWAY 24 AXB384
12:10:29	AXB384	TWR	WIND 010 DEGREES 10 KNOTS CAUTION FOR CROSS WIND

12:10:34	TWR	AXB384	COPIED AXB384
12:12:05	AXB384	TWR	VACATE VIA E
12:12:11	AXB384	TWR	AXB384 TWR LANDED 12 PROCEED TO BAY NO 9
12:12:22	AXB384	TWR	AXB384 TWR SAY AGAIN... REPORT POSITION SIR
12:12:32	TWR	AXB384	WE... WE CROSSED THE RUNWAY WE ARE ON KACHCHA AND THERE IS NALA OVER HERE. REQUEST DISEMBARKATION OVER HERE
12:12:44	AXB384	TWR	AXB384 ROGER STANDBY SIR HOLD POSITION
12:12:50	TWR	AXB384	HOLDING POSITION AXB384
12:13:17	AXB384	TWR	AXB384 TWR CONFIRM ANY OTHER ASSISTANCE REQUIRED
12:13:23	TWR	AXB384	AFFIRM AXB384 WE REQUIRED ASSISTANCE WE ARE STUCK OVER HERE
12:13:29	AXB384	TWR	ROGER SIR WE ARE INFORMING YOUR OPERATOR THEY WILL BE SENDING TOW TRACTOR AND AS WELL AS DISEMBARKATION VEHICLE. WE ARE SENDING OUR FOLLOW ME SERVICE THERE SIR
12:13:38	TWR	AXB384	THANK YOU SIR THANK YOU VERY MUCH
12:13:45	AXB384	TWR	AXB384 CONFIRM YOU ARE CLEAR OF RUNWAY SIR
12:13:52	TWR	AXB384	YES WE ARE CLEAR OF RUNWAY WE ALREADY CROSSED RWY AND ITS NALA OVER HERE
12:13:59	AXB384	TWR	AXB384 ROGER SIR
12:14:55	AXB384	TWR	AXB384 TWR REPORT POB
12:14:59	TWR	AXB384	189 AXB384
12:15:02	AXB384	TWR	AXB384 TWR ROGER SIR
12:20:43	AXB384	TWR	AXB384 TWR OPERATOR IS SENDING TOW TRACTOR ANY OTHER ASSISTANCE REQUIRED
12:20:50	TWR	AXB384	I THINK WE HAVE TO DISEMBARK AT THIS POSITION AXB384
12:20:56	AXB384	TWR	WE HAVE INFORMED ABOUT THAT ALSO THEY WILL BE SENDING VEHICLE ALSO
12:20:59	TWR	AXB384	THANK YOU MADAM THANK YOU VERY MUCH AND RWY IS TOO SLIPPERY AND BRAKE COULD NOT WORK
12:21:06	AXB384	TWR	ROGER SIR, WE HAVE INFORMED THAT END OF THE RWY IS WET ACTUALLY
12:21:10	TWR	AXB384	ROGER THANK YOU MAM THANK YOU VERY MUCH THANKS FOR ASSISTANCE
12:21:14	AXB384	TWR	YOU ARE WELCOME SIR

## 1.10 AERODROME INFORMATION

1.10.1 Mangalore International Airport is operated by Airports Authority of India.

The IATA Location Identifier Code is “IXE” and ICAO Location Indicator Code is “VOML”. Aerodrome is located on hilltop and design of the Runway is a table top.

Mangalore has been considered as Category ‘C’ airport by Air India Express operations.

The Airport Rescue and Fire Fighting Services is Category ‘7’.

Airport Co-ordinates: - Lat: 12° 57’ 43.42” N, Long: 74°53’23.22” E.

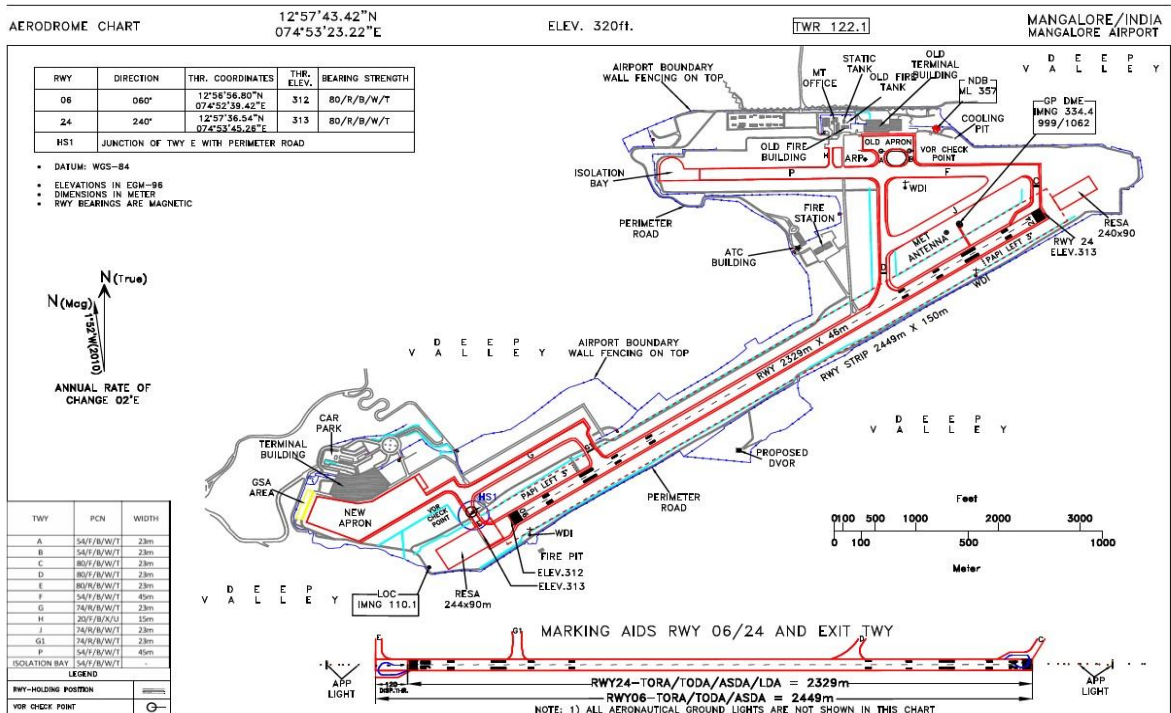
Elevation: 338 feet (103 meters).

There are two runways with orientation 09/27 and 06/24. However, the runway 09/27 was not in use.

The details of runway distances is as below;

Runway	TORA (M)	TODA (M)	ASDA (M)	LDA (M)	WIDTH (M)	RESA (M)
06	2450	2450	2450	2330	46	90 x 90
24	2330	2330	2330	2330	46	174 X 90 M up to a distance of 124 M from RWY strip and beyond 124 M width gradually reduces to 74 M.

Last Runway friction test for runway 06/24 was carried out on 19.05.2019 and was within the limits.



Pic 5: Mangalore Aerodrome Chart

## 1.11 FLIGHT RECORDERS

Both Solid State Cockpit Voice Recorder (SSCVR) and Solid-State Flight Data Recorder (SSFDR) were downloaded and readout was carried out.

### 1.11.1 Cockpit Voice Recorder (CVR)

A total of last 02:05:02 hours of recording was available in CVR. The CVR recording was synchronized with the ATC tape to get the approximate time (in UTC) of call outs. Following are the salient observations:-

- The aircraft came in contact with Mangalore Approach at 114000 UTC.
- At 114300 UTC, the crew were discussing about clouds in the flight path ahead.
- At 114325 UTC, PIC informs ATC about the weather ahead and requested for vectoring for ILS approach runway 24.
- At 115252 UTC, the crew confirms the status over the airfield for which the ATC informed “No Rain Runway Dry”.
- At 115721 UTC, Approach Control cleared aircraft for ILS approach runway 24.
- At 115858 UTC, PIC calls out “Glide Slope Captured” and informs ATC that they are on ILS runway 24.
- At 115912 UTC, Approach control informs crew that they are 6 ½ miles from touchdown and asked to contact Tower.
- At 115923 UTC, the crew contacted Tower and informed they are on ILS runway 24 and ATC clears the aircraft for landing runway 24 and informed winds are 270°/12 knots.
- At 115940 UTC, the crew carried out landing checklist.
- At 120015 UTC, PIC calls out “Runway in sight”.
- At 120052 UTC, Auto call out of “1000” was heard in the cockpit.
- At 120121 UTC, PIC calls out “correcting”.
- At 120124 UTC, Auto call out of “500” was heard in the cockpit.
- At 120131 UTC, “Glide Slope” warning was heard in the cockpit and PIC immediately calls out “Go Around”.
- At 120135 UTC, co-pilot informs Tower that they are going around and ATC asked them to contact Approach Control.

- At 120244 UTC, the crew came in contact with Approach and co-pilot informs that they are going around due to unstabilized approach as conveyed by PIC.
- At 120309 UTC, Approach Control confirms with PIC if they will be doing one more approach for which the crew affirmed.
- At 120341 UTC, Auto call out of “2500” was heard in the cockpit.
- At 120607 UTC, ATC Approach informed winds are 010°/08 knots.
- At 120758 UTC, ATC Approach clears aircraft for ILS Approach runway 24.
- At 120824 UTC, ATC Approach informed crew that they are 8 1/2 miles to touchdown and advices to contact Tower.
- At 120837 UTC, crew contacts tower and informs they are on localizer runway 24.
- At 120847 UTC, Tower informs crew to exercise caution as end of the runway 24 is wet.
- At 120901 UTC, Tower gives landing clearance and informs winds as 020°/07 knots.
- At 120932 UTC, crew carried out landing checklist.
- At 121002 UTC, PIC tells co-pilot that “after second missed approach we have to divert”.
- At 121013 UTC, PIC calls out “runway in sight”.
- At 21029 UTC, ATC gives wind information as 010°/10 knots and cautions for cross winds. Crew read back the same.
- At 121037 UTC, Auto call out of “1000” was heard in the cockpit and simultaneously co-pilot calls out “Stabilized”.
- At 121049 UTC, Co-pilot calls out for “Speed” for which PIC calls out “Correcting”
- At 121107 UTC, Auto callout of “500” was heard in the cockpit.
- At 121111 UTC, Auto callout of “Approaching Minimums” was heard in the cockpit with PIC calling out for “Wipers”.
- At 121117 UTC, Auto callout of “Minimums” was heard in the cockpit and simultaneously PIC calls out “Visual Landing”.
- At 121122 UTC, there was a BEEP sound with co-pilot again calling out for “Speed”.
- At 121130 UTC, Auto call out of “100” was heard in the cockpit along with co-pilot calling out “We are too high...we should go around”.
- At 121132 UTC, auto call out of 50...40...30...was heard in the cockpit.

- Auto call out of “20” was heard at 121135 UTC and touchdown (Thud) sound was heard at 121142 UTC.
- At 121145 UTC, Co-pilot calls out for “Brakes” and simultaneously calls out “Autobrakes Disarm”.
- At 121149 UTC, Co-pilot calls out “Reversers”.
- At 121201 UTC, PIC calls out “Stand on Brakes....Stand on Brakes” for which the co-pilot replies “I am standing”.
- At 121207 UTC, ATC tower advises crew to vacate via taxiway “E”.
- At 121232 UTC, PIC informs ATC that aircraft has crossed the runway and entered Katcha and requests for disembarkation there, for which ATC advised them to hold position.
- At 121317 UTC, ATC asked the crew if they require any assistance for which PIC asked they require assistance as the aircraft is stuck.
- At 121400 UTC, PIC asks co-pilot for after landing checklist.
- At 121505 UTC, PIC discusses with co-pilot that they should have taken max... slippery runway.
- At 121513 UTC, crew carried out after shutdown checklist.
- At 121625 UTC, crew were discussing that they should have carried out “Go Around”. Co-pilot said it was 4 whites on PAPI.
- At 121655 UTC, PIC was discussing that he did not wanted to continue straight because of valley ahead due to which he turned the aircraft to right.
- At 121717 UTC, crew carried out Secure checklist.
- CVR recording ended at 121727 UTC.

### **1.11.2 Digital Flight Data Recorder (DFDR)**

#### First Approach

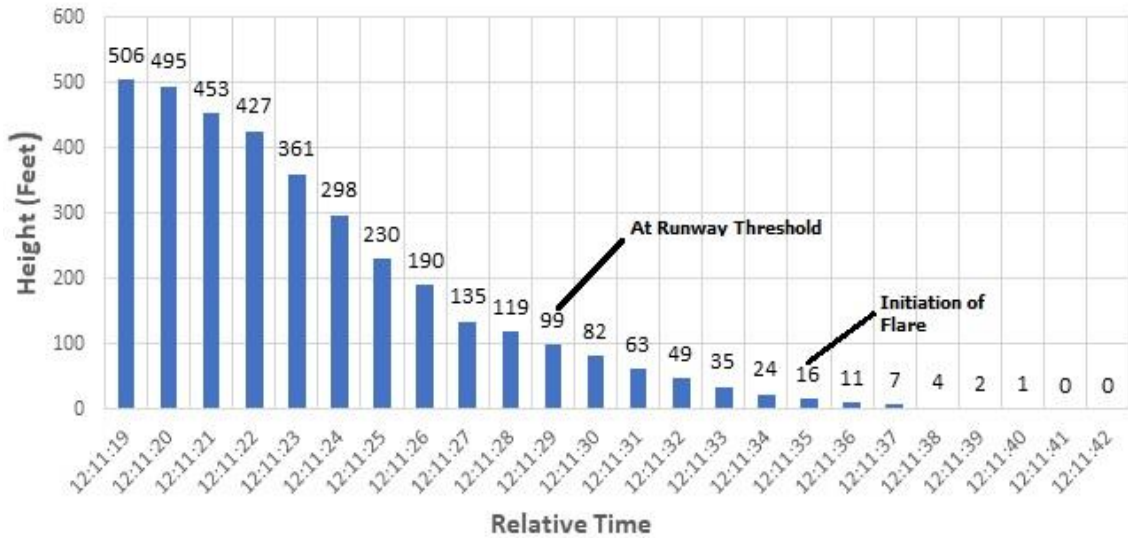
- The autopilot was disconnected at relative time 120054, at radio height of 745 ft, with speed of 146 knots and ROD of 720 ft/min.
- At relative time 120119, the speed was reduced to 133.5 knots.
- At relative time 120127, at radio height of 492 feet, TO/GA was engaged i.e. at this time the “Go-Around” was initiated. The speed at this point was 135 knots.

## Second Approach

- At relative time 121035, the aircraft was at 1013 feet with speed 151 knots, vertical speed of -832.5 feet/min.
- At relative time 121119, the autopilot was disengaged at Radio Height of 506 feet and ROD of -772.5 feet/min. Winds were 015°/17.5 Kts as per FMC, i.e. 12.37 knots of tail wind and 12.37 knots of cross wind.
- At relative time 121123, when the aircraft was at approx.. 300 ft AGL, thrust was increased to 70.5 % on LH Engine and 69.9 % on RH Engine. Speed was increased to 153 Kts. ROD reduced to approximately 600 feet/min with pitch of 0°. Winds were 090°/15 kts i.e. 13 kts of tail wind component and 8 kts of cross wind.
- At relative time 121142, the aircraft made touchdown with pitch of 1.6° UP, vertical acceleration of 1.495g, speed of 147.5 knots & flaps 40°. “Auto Brakes” was not selected. The spoilers/speed brakes were deployed, however, Thrust Reversers were not deployed at touchdown. Winds were 171°/10.5 kts i.e. 4 kts of head wind and 10 kts of cross wind.
- At relative time 121159, i.e. 17 seconds after touchdown, the thrust reversers were deployed. Brake Pressure Left was 2968 psi & Right was 2941 psi.
- At relative time 121206. i.e. 24 seconds after touchdown, there was an appreciable shift of the magnetic heading from 246.8° to 251.4° and it kept on changing thereafter. The aircraft Ground Speed was 54.5 kts.
- At relative time 121219 i.e. 37 seconds after touchdown, the aircraft came to its final halt with heading 276.7°.

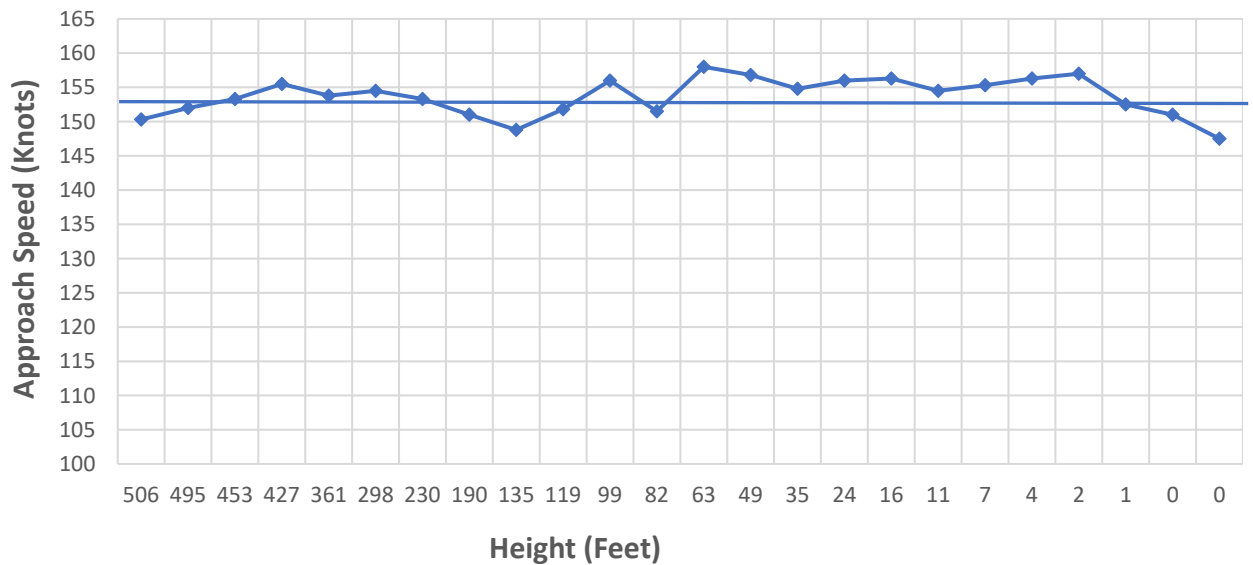
Based on the DFDR data, some critical parameters relevant to the incident were analysed. The salient observations made are as follows: -

- The autopilot was disengaged at radio height of 506 feet at relative time 121119 and the aircraft made touch down at relative time 121142, i.e. the aircraft took 23 seconds to descend from 506 feet to ground.
- The aircraft was at 99 feet AGL with Vapp of 156 knots and Pitch of - 2.11° (Nose Down) while overflying runway 24 threshold.
- The aircraft rolled for a distance of about 1571 meters and for a duration of 37 seconds after touchdown before coming to its final halt.



**Pic 6:** Graph showing Change in height with Time (500 feet to Touchdown).

- The Reference speed  $V_{ref}$  was calculated as 138 knots. The Approach speed ( $V_{app}$ ) will be  $V_{ref} + 5$  knots i.e.  $V_{app}$  of 143 knots.
- The approach speed was observed to be 151 knots at 1013 feet AGL and 147.5 knots at touchdown with maximum value of 158 knots at 63 feet AGL.



**Pic 7:** Graph showing Change in Approach Speed with height (500 feet to Touchdown).

- The ROD was observed to be 832.5 ft/min at 1013 feet AGL and 26.25 ft/min at touchdown with maximum value of 928 ft/min at 82 feet AGL.



- The brake pressure was observed to have increased from 8 psi for LMW (Left Main Wheel) & 11 psi for RMW (Right Main Wheel) at the time of touchdown to 3022 psi (LMW) & 2988 psi (RMW) in 13 seconds after touchdown.

## 1.12 WRECKAGE AND IMPACT INFORMATION

The aircraft was high on approach and made a delayed touchdown on runway at a distance of about 900 meters ahead of runway 24 threshold. The aircraft rolled for about 1488 meters on the runway. The aircraft started deviating towards right just before "Taxiway E" and entered unpaved surface from "Taxiway E" intersection. Tyre marks of the aircraft were observed on the runway before taxiway E intersection which is evident due to heavy application of brakes by the crew. The left main wheel ran over one of the runway edge lights (at taxiway E intersection) which was broken.



*Pic 8: Touchdown and Final Resting Position of Aircraft.*



***Pic 9: Final Resting position of the aircraft with tyre marks.***

The aircraft travelled for about 80 meters on the unpaved surface (soft ground with mud) before coming to its final halt. The nose wheel of the aircraft ran over the open drain in the unpaved surface which probably arrested the speed of the aircraft. The aircraft was resting on the unpaved surface heading 276° and about 45 meters to the left of Taxiway 'E'.



***Pic 10: Aircraft stopped after Nose wheel ran over open drain.***

Lower surface of Left engine cowling was found damaged with lots of mud.

All switches/CB's in the cockpit were found in normal positions. All controls like aileron, rudder, etc. were at neutral positions.

There was no evidence of disintegration of any part of the aircraft in flight and the aircraft was found confined to its final resting position.

### **1.13 MEDICAL AND PATHOLOGICAL INFORMATION**

The crew had undergone pre-flight medical (Breath Analyser Test) at Mangalore before first flight (Mangalore - Dubai) as per requirement of CAR Section 5, Series F, Part III.

The test was negative i.e. Both cockpit crew were not under the influence of alcohol.

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

### **1.14 FIRE**

There was no fire.

### **1.15 SURVIVAL ASPECTS**

The Incident was survivable.

### **1.16 TESTS AND RESEARCH**

#### **1.16.1 Brake Assembly Functional test**

All four main wheel brake assemblies were removed from the incidented aircraft and quarantined for further examination to ascertain the serviceability. All four brake assemblies were subjected to Functional Test at a DGCA approved shop in the presence of investigating team.

During the examination, it was observed that all brake assemblies were in serviceable condition. The damages and anomalies observed were sustained during the incident.

### **1.17 ORGANISATIONAL AND MANAGEMENT INFORMATION**

**1.17.1** The aircraft was operated by a scheduled operator holding AOP No. S-14 in Passenger and Cargo Category which is valid till 21.04.2023. The airline commenced its operations in 2005. The headquarters of the operator is Kochi. The operator currently has a fleet of 25 Boeing 737-800 aircraft.

The maintenance of the aircraft is being carried out by M/s Air India Engineering Services Ltd. (AIESL) which is a DGCA CAR 145 approved MRO. There is in house training facility for the pilots, cabin crew, airport services and Engineering.

**1.17.2** The organisation has formulated an Operations Manual based on the existing regulations which was duly approved by DGCA.

Scrutiny of the Operations Manual revealed the following: -

- There was no specific procedure formulated for abnormal situations such as runway excursion etc.
- There was no training specified for tail wind landing in initial and re-current training program for crew.

## **1.18 ADDITIONAL INFORMATION**

### **1.18.1 Landing Procedure, Techniques & Configurations**

In the following paragraphs relevant portion of the Operations Manual (OM) of the Aircraft Operator, Flight Crew Operations Manual (FCOM) & Quick Reference Handbook (QRH) of the aircraft are discussed to understand the standard procedures in place which has been corroborated with the present case.

#### **1.18.1.1 Definition of Stabilised Approach**

An approach which is flown in a controlled and appropriate manner in terms of configuration, energy and control of the flight path from a pre-determined point or altitude/height down to a point 50 feet above the threshold or the point where the flare manoeuvre is initiated, if higher.

#### **1.18.1.2 Stabilised Approach Procedure**

- a) A stabilized approach is characterized by a constant-angle, constant-rate of descent approach profile ending near the touchdown point, where the landing maneuver begins. A stabilized approach is the safest profile in all but special cases, in which another profile may be required by unusual conditions.
- b) As a Policy, Air India Express adheres to the “Approach and Missed Approach” operating practices as stated in FCTM with special emphasis on the paragraph on “Stabilized Approach Recommendations”. In addition to the above, the following

salient points need to be kept in mind when executing any approach. These points are in line with DGCA Operations Circulars 9/2009 and 1/2013

- c) Flight should be stabilized by 1000“ AFE in IMC, and by 500“ AFE in VMC.
- d) The criteria of what constitutes a Stabilized Approach are given in the next paragraph.
- e) An approach that becomes un-stabilized below 1000“ HAT in IMC and below 500“ HAT in VMC requires an immediate “go around”.

### **Conditions required for obtaining a Stabilized Approach**

A large percentage of incidents and accidents occur during the approach and landing or take off phase of flight. This is also the phase where there is transition from automated flight to manual flight, instrument to visual reference and vice versa. It is critical that SOPs are followed meticulously in these phases of flight. Pilots need to bear in mind that a good landing is the result of a good approach which is built on adherence to SOPs. A good landing is not one that the passengers perceive as a soft landing, but one that is made at the correct point on the runway with the correct flight parameters. While the approach can be controlled to achieve a good standard through adherence to SOPs resulting in safe landing, however an attempt to cushion a “decent” landing to make a soft landing could result in a delayed touchdown that would need harsh deceleration to maintain the aircraft on the runway or even worse a runway excursion with possible catastrophic results.

If, for any reasons, the approach is un-stabilized, a go-around is a safer option which affords the pilot another opportunity to conduct a safe approach to land. It is reiterated that strict adherence to the standard operating procedures for approach and landing, would result in decent landings acceptable within the limitations of the aircraft, without compromising stopping distance requirements.

### **Monitored Approach**

It is an Airline Policy that one Pilot will monitor the flight instruments continuously during approach for out of parameter excursion. When carrying out an instrument approach in weather conditions near to or at minimums, the Pilot Not Flying (PNF) will remain Head Down” and monitor the flight instruments to touch down and through the missed approach procedure. The Pilot Flying shall remain on instrument upto 100 feet above minimums but start adjusting his scan for outside visual cues below 500 feet.

- a) The PF shall loudly announce his decision either Landing or “Going around”. If there is no call by PF at DA the PNF shall initiate a missed approach.
- b) The PF will execute a missed approach should visual cues not be seen or not confirm the alignment of the aircraft with the runway. During missed approach PNF shall crosscheck attitude on standby horizon.
- c) The PNF shall at all times remain on instruments and call out air speed deviations, unusual altitude, etc. to touch down or through the missed approach and also appropriate air speed during the roll out.

**Stabilized Approach Threshold**

- a) The following Stabilization thresholds need to be met:
  - i. NPA/PAR - FAF
  - ii. ILS - 1000 ft AGL
  - iii. Visual - 500 ft AGL
  - iv. Circling - 400 ft AGL
- b) By this threshold, the airplane should meet the “Stabilised Approach criteria” given in para A25.1.4.
- c) During the approach the altitude on the FCU shall be set in the following order:
  - i. ATC cleared altitude
  - ii. Minimum altitude at Final approach Fix.
  - iii. Initial altitude constraint or Level segment of the “go around procedure” as per charts

**Significant Deviation**

- (a) Rate of descent more than 1000 fpm or less than 400 fpm
- (b) Approach speed VAPP Target + 10 or - 5 Kts
- (c) Bank Angle greater than 7°
- (d) Pitch Attitude Lower than -2.5° or higher than +10°
- (e) Localiser 1 dot deviation
- (f) Glide slope 1 dot deviation
- (g) Course Greater than ½ dot or 2.5° (VOR) or 5°(ADF)
- (h) Thrust any significant deviation from average thrust setting

Note:

*1. It is responsibility of the PM to call out any significant deviation.*

2. *360° turns on the Final Approach is prohibited and a missed approach must be executed whenever the airplane is not stabilized during this phase.*
3. *It requires a great deal of self-discipline for the PM to remain “heads down” at DA (H) and below.*

### **Stabilized Approach Criteria**

- a) All appropriate briefings and checklists should be accomplished before 1000 feet Height Above Threshold (HAT) in instrument meteorological conditions (IMC), and before 500 feet HAT in Visual Meteorological Conditions (VMC).
- b) An approach is considered stabilised when all of the following criteria are met:
  - i. The airplane is on the correct flight path
  - ii. Only small changes in Heading, Pitch and Thrust are required to maintain that path.
  - iii. The airplane speed is not more than  $V_{app} + 10$  knots IAS and not lower than  $V_{app} - 5$  knots trending to  $V_{app}$  and not lower than  $V_{ref}$ .
  - iv. The airplane is in the correct landing configuration (with Speed brakes retracted)
  - v. The sink rate is no more than 1000 feet/minute. If an approach requires a higher sink rate, a special briefing is required.
  - vi. The power setting is appropriate to the configuration
  - vii. All briefings and checklists have been performed.
- c) Specific types of approaches are considered as stabilised if they also fulfil the following:
  - i. ILS Cat-1 approaches are flown within 1 dot of G/ S and localizer.
  - ii. Visual Approach: the Wings must be level on final approach when the airplane reaches 500 feet HAT.
  - iii. Circling Approach: The wings must be level on final approach when the airplane reaches the 300 feet HAT.
- d) These conditions should be maintained throughout the rest of the approach for it to be considered a stabilized approach. If the above criteria cannot be established and maintained, initiate a “go-around”.
- e) At 100 feet HAT for all visual approaches, the airplane should be positioned so that the flight deck is within, and tracking to remain within, the lateral confines of the runway edges extended.
- f) As the airplane crosses the runway threshold it should be:
  - i. Stabilized on target airspeed to within +10 knots until arresting descent rate at flare.
  - ii. On a stabilized flight path using normal manoeuvring.

- iii. Positioned to make a normal landing in the touchdown zone (the first 3000' or first third of the runway, whichever is less).

### **Mandatory “Go-Around”**

- a) Adhere to the instructions given in the paragraph on “Mandatory Missed Approach” in FCTM, Chapter-5.

In addition:

- i. If the above criteria for a Stabilized Approach cannot be established and maintained, initiate a go-around.
- ii. The “Go-Around” call can be given by either PF or PM.
- iii. Once “Go-Around” is called, it is mandatory to execute the “Go-around”.

### **Minimum Altitude for being stabilized**

If an approach is not stabilized or gets destabilized due to any significant deviation it must be stabilized latest by 1000 feet AGL during an instrument approach, 500 feet AGL during a visual approach, 300 feet AGL during a circling approach.

### **Procedure to be followed if the approach is not stabilized at minimum altitude**

In case the above altitude limitation for stabilization is not achieved the pilot is required to immediately execute the Missed Approach Procedure.

#### **1.18.1.3 Landing Distance Calculation**

FCOM/QRH of Boeing 737-800 aircraft provides inflight performance calculation table which provides reference landing distance for crew to select the type of brakes (Autobrakes/Manual) required to land the aircraft within runway as per the prevailing conditions.

Approximate landing distance calculations were carried out in accordance with the method provided in the Boeing 737 FCOM/QRH for the event flight.

The crew carried out flap 40 landing. Following parameters were recorded/calculated/reported at the time of touchdown: -

- Landing Weight: 64268 Kgs (As per Flight Plan)
- Altitude (Runway Elevation): 338 feet (103 m)
- Wind: 9.5 knots Tail Wind
- Slope: 0%
- Temperature: 27° C (ISA temperature was calculated to be 15.6° C)
- Approach Speed: 147.5 knots (Vref 40 = 138 knots)
- Thrust Reversers: Both operative



The runway was reported to be dry, however, the ATC tower reported end of the runway as wet. Hence, calculations were carried out for both conditions.

Based on the above parameters: -

For Runway Condition Dry with Max Manual Braking

- Max Manual Braking Reference distance = 2920 feet
- Landing weight correction =  $-160 * [(65,000 \text{ kg} - 64,268 \text{ kg}) / 5000 \text{ kg}] = -23 \text{ feet}$
- Altitude correction =  $+60 * [338 \text{ ft}/1000 \text{ ft}] = +20 \text{ feet}$
- Wind correction =  $+380 * [9.5 \text{ kts} / 10 \text{ kts}] = +361 \text{ feet}$
- Temperature correction =  $+60 * [27^\circ\text{C}-15.6^\circ\text{C}] / 10^\circ\text{C}] = +68 \text{ feet}$
- Speed correction =  $+110 * [(147.5 \text{ kts} -138 \text{ kts}) / 5\text{kts}] = +209 \text{ feet}$

For Runway Condition Dry with Max Manual Braking, the Reference Landing Distance required was calculated as 3555 feet.

For Runway Condition Dry with Auto Brakes 3

- Auto Brakes 3 Reference distance = 5130 feet
- Landing weight correction =  $-320 * [(65,000 \text{ kg} - 64,268 \text{ kg}) / 5000 \text{ kg}] = -47 \text{ feet}$
- Altitude correction =  $+140 * [338 \text{ ft}/1000 \text{ ft}] = +47 \text{ feet}$
- Wind correction =  $+770 * [9.5 \text{ kts} / 10 \text{ kts}] = +732 \text{ feet}$
- Temperature correction =  $+140 * [27^\circ\text{C}-15.6^\circ\text{C}] / 10^\circ\text{C}] = +159 \text{ feet}$
- Speed correction =  $+280 * [(147.5 \text{ kts} -138 \text{ kts}) / 5 \text{ kts}] = +532 \text{ feet}$

For Runway Condition Dry with Auto Brakes 3, the Reference Landing Distance required was calculated as 6553 feet.

For Good Reported Braking Action with Max manual Braking

- Max Manual Braking Reference distance = 4000 feet
- Landing weight correction =  $-230 * [(65,000 \text{ kg} - 64,268 \text{ kg}) / 5000 \text{ kg}] = -34 \text{ feet}$
- Altitude correction =  $+100 * [338 \text{ ft}/1000 \text{ ft}] = +34 \text{ feet}$
- Wind correction =  $+640 * [9.5 \text{ kts} / 10 \text{ kts}] = +608 \text{ feet}$
- Temperature correction =  $+100 * [27^\circ\text{C}-15.6^\circ\text{C}] / 10^\circ\text{C}] = +113 \text{ feet}$
- Speed correction =  $+150 * [(147.5 \text{ kts} -138 \text{ kts}) / 5\text{kts}] = +285 \text{ feet}$

For Good Reporting Braking Action with Max Manual Braking, the Reference Landing Distance required was calculated as 5006 feet.

For Good Reported Braking Action with Auto Brakes 3

- Auto Brakes 3 Reference distance = 5160 feet

- Landing weight correction =  $-320 * [(65,000 \text{ kg} - 64,268 \text{ kg}) / 5000 \text{ kg}] = -47 \text{ feet}$
- Altitude correction =  $+140 * [338 \text{ ft}/1000 \text{ ft}] = +47 \text{ feet}$
- Wind correction =  $+780 * [9.5 \text{ kts} / 10 \text{ kts}] = +741 \text{ feet}$
- Temperature correction =  $+140 * [27^\circ\text{C}-15.6^\circ\text{C}] / 10^\circ\text{C}] = +159 \text{ feet}$
- Speed correction =  $+290 * [(147.5 \text{ kts} -138 \text{ kts}) / 5\text{kts}] = +551 \text{ feet}$

For Good Reported Braking Action with Auto Brakes 3, the Reference Landing Distance required was calculated as 6611 feet.

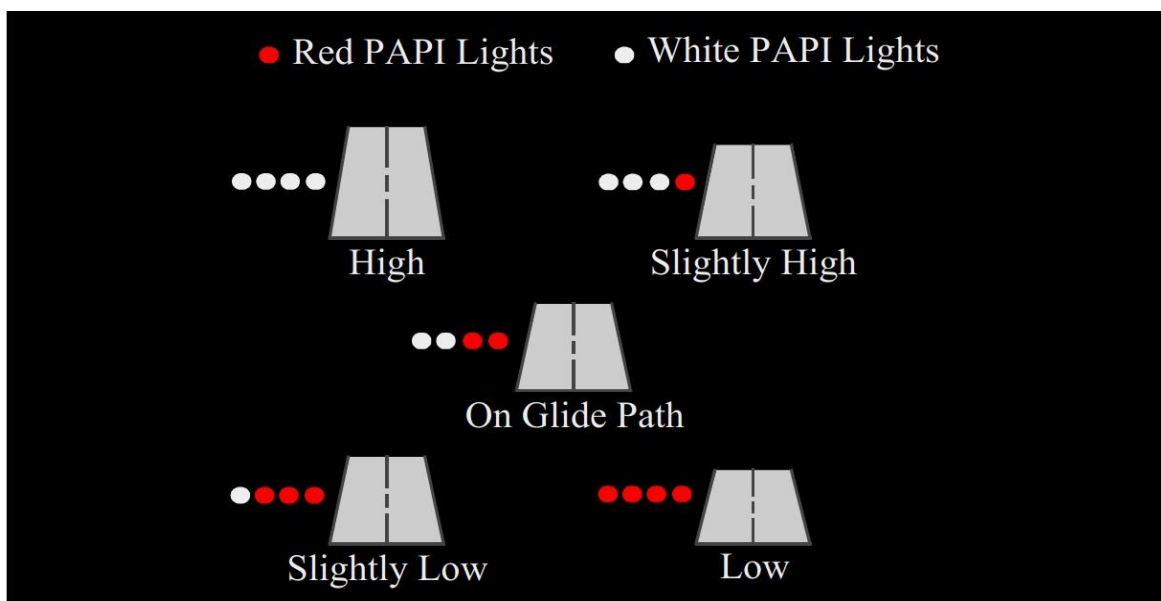
All Reference Landing Distances include an air distance allowance of 1000 feet from threshold to touchdown.

However, in this case the aircraft landed at 902 meters (2631 feet) ahead of runway 24 threshold, thereby only 1528 meters (5013 feet) of runway length was available for landing. Selecting Autobrakes for landing should have required more landing distance in the prevailing conditions. The crew did not selected Autobrakes for landing.

#### 1.18.1.4 Precision Approach Path Indicator

The Precision Approach Path Indicator (PAPI) uses lights which are normally on the left side of the runway. They are installed in a single row of light units.

When the airplane is on a normal 3° glide path, the pilot sees two white lights on the left and two red lights on the right. The PAPI may be safely used in relation to threshold crossing height, but may result in landing further down the runway. The PAPI is normally aligned to intersect the runway 1,000 to 1,500 feet beyond the threshold.



*Pic 11: PAPI Landing Geometry*

## **1.19 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES**

Nil

## **2 ANALYSIS**

### **2.1 SERVICEABILITY OF AIRCRAFT**

**2.1.1** The aircraft was manufactured in the year 2009. The aircraft was having a valid Certificate of Registration (C of R) at the time of incident. It was holding a valid Indian Certificate of Airworthiness (C of A) under category Normal, Sub-Division Passenger and valid for lifetime. Airworthiness Review Certificate (ARC) was valid at the time of incident. The aircraft had logged 34936 Airframe hours till the day of Incident. There was no snag reported by the pilot before the incidented flight.

All concerned Airworthiness Directives, mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engine were complied with as on the date of event.

Scrutiny of the Technical Log Book revealed that there was no snag pending on the aircraft prior to this occurrence. The last snag recorded was on 27<sup>th</sup> June 2019 and the snag was “Just before push back, crew reported that after pressurization brake pressure showed 2200 psi.”. The rectification action was carried out satisfactorily and the aircraft was released for flights.

“Load and Trim” sheet of this flight was prepared and center of gravity was found within limit.

**2.1.2** The brake assemblies were examined for their serviceability at a DGCA approved MRO in the presence of investigating team and no anomalies were observed on the brake assemblies. Damages on the wheels were during the incident.

### **2.2 WEATHER**

The visibility at the time of incident as per MET report was 6000 meters. At the time of giving landing clearance to the aircraft for runway 24, the ATC tower reported wind as 020°/07 knots i.e. 5.5 knots of tail wind & 3.5 knots of cross wind. Before touchdown, the tower reported winds as 010°/10 knots i.e. 6.5 knots of tail wind & 7.6 knots of cross

wind. However as per DFDR (FMC) data, the winds just before touchdown were 170°/11.5 knots which will give head wind component of 04 knots and cross wind component of 11 knots.

Although there was a considerable difference between the wind speed reported by the MET/ATC and the wind speed as per DFDR (FMC) data, the tail winds were still within the limits of organization's SOP for landing. Hence, it is concluded that the weather was not a contributory factor to the incident.

## **2.3 DFDR & CVR ANALYSIS.**

### **2.3.1 DFDR**

- The crew disengaged autopilot at 506 feet AGL and started descending manually.
- At 506 feet AGL
  - The rate of descent was 772.5 feet/min which was within the maximum permissible value of 1000 feet/minute.
  - The speed was 151 knots which was within the allowable limits of  $V_{app} + 10$  knots i.e. 153 knots (143+10).

Hence, the aircraft was stabilized by 500 feet AGL.

- From 506 feet till 99 feet radio height (aircraft height over threshold)
  - The average rate of descent was 729 feet/min which was within limits.
  - The average approach speed during this phase was more than 153 knots, which is a significant deviation from the stabilized criteria.
  - The aircraft took 12 seconds to descend from 506 feet to 99 feet.

Hence, the aircraft was not stabilized during this phase.

- The aircraft was at a height of 99 feet while overflying runway threshold which was twice the prescribed value of 50 feet height required for touchdown within touchdown zone.
  - The rate of descent was 902 feet/min which was high but within limits.
  - The approach speed was 156 knots which was again a significant deviation from the stabilized criteria.
  - The pitch attitude was 2.11° down.

Hence, the aircraft was high and not stabilized while overflying runway 24 threshold.

- From 99 feet till touchdown
  - The average rate of descent was 456 feet/min which was within limits.
  - The average approach speed was 155 knots, with 147.5 knots at touchdown, which was high and a significant deviation from the stabilized criteria. The trend can be seen in the Approach Speed Vs Height graph shown at Pic 7 which shows after 99 feet AGL the trend is always above the horizontal line which represents value of 153 knots i.e. maximum allowable speed ( $V_{app} + 10$  knots) during approach.
  - N1 left and right was increased upto 82% before decreasing it to idle power (32%) at touchdown which implies that the engine power was higher than required to flare the aircraft before making touchdown.
  - There was increase in pitch angle from  $0^\circ$  to  $1.7^\circ$  at the height of 16 feet AGL which implies initiation of flare.
  - Thereafter the aircraft floated for about 07 seconds over runway before touchdown which implies extended flare.
  - The aircraft took 13 seconds to touch down after overflying runway threshold at a height of 99 feet.
  - The aircraft landed at 902 meters (2960 feet) after runway threshold i.e. it landed well ahead of the touchdown area.
- From touchdown till the aircraft came to final halt.
  - Speed brakes were deployed immediately after touchdown and were functioning normally.
  - No Autobrakes was selected for landing. however, the manual braking started 07 seconds after touchdown.
  - The maximum brake pressure of 3000 psi was registered 13 seconds after touchdown which implies that the brakes were functioning normally.
  - The aircraft rolled for a distance of 1571 meters (5154 feet) and 37 seconds after touchdown till it came to its final rest.
  - 
  - There was an appreciable shift of the magnetic heading of  $12^\circ$  (changed from centerline to  $252^\circ$ ) to the right of the center line after 24 seconds of touchdown and is considered to be the point at which the aircraft was turned right and entered the unpaved surface. Aircraft Ground Speed was 54.5 kts.

- The aircraft travelled further for 83 meters (272 feet) and 13 seconds on the unpaved surface before coming to its final resting position.

### 2.3.2 CVR

- During the first approach and after obtaining landing clearance by the tower, PIC calls out “correcting” which implies that the aircraft was not stabilized at that point.
- Immediately after Auto call out of “500, “Glide Slope” warning was heard in the cockpit for which PIC immediately calls out “Go Around” and initiates the same.
- During the second approach for landing, Tower informs crew to exercise caution as end of the runway 24 was wet.
- Crew carried out landing checklist after Tower gave landing clearance and informed winds are 020°/07 knots. Also, PIC tells co-pilot that in case of second missed approach they have to divert.
- When Auto call out of “1000” was heard in the cockpit, co-pilot called out “Stabilized” which was also confirmed with the DFDR data.
- During final approach, Co-pilot calls out for “Speed” for which PIC calls out “Correcting”. This is in line with DFDR data where it was observed that the speed was reduced below the Vapp speed of 143 knots which the PIC corrected by increasing power.
- Below 500 feet, co-pilot again calls out for “Speed”, however this time there was no response by the PIC. This is in line with the DFDR data where it was observed that below minimums, the Approach speed was above the limit of Vapp + 10 i.e. 153 knots.
- With Auto call out of “100” in the cockpit, co-pilot called out “We are too high...we should go around”. This again is in line with DFDR data that the aircraft was at 99 feet while overflying runway 24 threshold.
- Auto call out of “20” was heard at 121135 UTC and touchdown (Thud) sound was heard at 121142 UTC i.e. it took 07 seconds for aircraft to touchdown from a height of 20 feet. This is in line with the DFDR where it was observed that the aircraft floated for about 07 seconds (from 16 feet to touchdown) before touchdown.
- At 121145 UTC, Co-pilot calls out for “Brakes” and simultaneously calls out “Autobrakes Disarm”. However, as per DFDR, no autobrakes were selected for landing.

- After 07 seconds of touchdown, the Co-pilot calls out “Reversers”. This is in line with DFDR where it was observed that the thrust reversers were deployed only after 17 second of touchdown.
- PIC calls out “Stand on Brakes....Stand on Brakes” for which the co-pilot replied “I am standing”. This was consistent with DFDR as the crew applied maximum manual braking which attained maximum value of 3000 psi after 13 seconds of touchdown.
- After aircraft came to its final halt, PIC informed ATC that the aircraft had crossed the runway and entered Katcha and requested for disembarkation.
- Crew carried out after landing checklist.
- Crew were discussing that they should have carried out “Go Around”. Co-pilot said they were high as it was showing 04 whites on PAPI.
- Before CVR recording ended, the PIC was discussing with co-pilot that he did not wanted to continue straight because of valley ahead due to which he turned the aircraft to right. This is also in line with DFDR data that, after 24 seconds of touchdown, there was sudden change in aircraft heading.

## **2.4 OPERATIONAL FACTORS**

### **2.4.1 CREW QUALIFICATION**

Both pilots were qualified to operate the flight. PIC had a total flying experience of about 8170 Hrs and Co-pilot had a total experience of about 460 hrs. Their medical and all trainings were current as on date of incident.

The crew were paired for the first time to operate the flight. The PIC had operated to Mangalore before and co-pilot was based in Mangalore. Therefore, the crew were familiar with the Mangalore airport.

### **2.4.2 CREW HANDLING OF THE AIRCRAFT AND DECISION MAKING**

During the first approach, after Mangalore Tower gave landing clearance to the aircraft for runway 24, the crew carried out landing checklist. At around 500 feet AGL, GPWS warning of “Glide Slope” came and PIC immediately called out “Go Around”. PIC carried out “Go-Around” and requested ATC for second ILS approach runway 24. During the second approach, the crew came in contact with tower and informed that they are on

localizer runway 24. The Tower informed crew that the end of runway 24 is wet. The Tower gave landing clearance and informed winds as 020°/07 knots. The crew carried out landing checklist and selected flap 40 for landing.

PIC informed co-pilot that in case of second missed approach they have to divert. The tower again reported winds as 010°/10 knots to caution for cross winds. At 1000 feet AGL, the aircraft was stabilized. At 621 feet AGL, the speed of the aircraft reduced to 141 knots i.e. below Vapp speed of 143 knots for which the co-pilot also called out “Speed”. The PIC called out “Correcting” and increased the speed by increasing power. The PIC disengaged Autopilot/Auto-throttle at about 500 feet and started flying manually. At around 450 feet, the co-pilot again called out “speed” as the speed was raised to 153.3 knots i.e. higher than allowable value of 153 knots to meet the stabilized criteria. However, at this time there was no response from the PIC. The speed during this phase was above 153 knots. During this phase PIC was trying to maintain the rate of descent within the allowable limits by maintaining high power settings to meet the stabilized criteria. The aircraft was at height of 99 feet AGL while overflying threshold runway 24 and the speed was 156 knots which implies that the aircraft was too high and was not stabilized. At this point, the co-pilot also called out that they are too high and they should “Go Around”. However, the PIC continued landing and did not carry out “Go Around” which was non-adherence to the laid down SOP.

The PIC initiated flare at 16 feet, however, there was no significant change in pitch, the speed at this point was 156 knots. The aircraft thereafter floated for 07 seconds before touch down at 902 meters (2959 feet) ahead of runway 24 threshold, which was well ahead of the touch down zone. The spoilers/speed brakes were deployed at touchdown i.e. without any delay. The PIC did not deploy thrust reversers immediately after touchdown and deployed only after 17 seconds of touchdown after co-pilot called out for thrust reversers. This implies that PIC was still not committed for landing considering the fact that once the Thrust Reversers are deployed, he cannot carry out “go-around”. The PIC did not select Autobrakes and applied manual braking only after 07 seconds of touchdown and maximum brake pressure was attained after 13 seconds of touchdown. He also asked co-pilot to stand on brakes to apply maximum manual braking. However, as the aircraft did not stop and the end of runway 24 was approaching, the PIC deliberately turned the aircraft to right. This was evident from the conversation with co-pilot recorded in the CVR that he did not wanted to continue straight because of valley ahead. The aircraft exited the paved surface from Taxiway ‘E’ intersection at a speed of 55 knots



before coming to its final resting position at 80 meters right of runway edge. The PIC informed ATC that the aircraft had crossed the runway and is on unpaved surface. He also requested ATC for assistance for disembarkation at the same point as the aircraft was stuck on the ground. The crew carried out after shutdown and secure checklist. The PIC thereafter told tower that the runway was slippery and the brakes were not working without realizing that the tower reported end of the runway wet before giving landing clearance.

The above indicates lack of pilot's handling of the situation. The PIC should have carried out "Go-Around" when the aircraft was not stabilized below minimums which was also conveyed by the co-pilot. Instead, he kept on focusing on keeping the ROD within the limits by maintaining high power settings and not considering the significant deviation in approach speed during this phase. Thereafter, his indecision to carry out a "go-around" after touchdown resulted in delayed deployment of thrust reversers, which further aggravated the situation.

## **2.5 ORGANISATION ASPECT**

**2.5.1** The organisation has formulated an "Operations Manual" based on the existing regulations which was duly approved by DGCA. Scrutiny of the "Operations Manual" revealed that there was no specific procedure formulated for such abnormal situations of runway excursion etc. In the present case, the crew asked ATC to provide assistance only for disembarkation without actually analyzing the situation inside and outside the aircraft. A specific procedure formulated in this regard will help the crew to take necessary actions as per the procedure, which will ensure overall safety of the aircraft without any delay.

**2.5.2** The scrutiny of the "Operations Manual" also revealed that there is no training specified for tail wind landing in "initial and re-current training" for pilots. The organisation is operating regular flights to the airfields like Mangalore, where the weather conditions changes abruptly and frequently, as it was observed in the present case where the winds changed from head wind to tail wind during the final approach. The operating crew will be more assured to carry out the landings with tail winds and adjust according to the current weather if such training is included in the curriculum.

## 2.6 CIRCUMSTANCES LEADING TO THE INCIDENT

The ATC gave landing clearance to aircraft for runway 24 and informed winds as 020°/07 knots. The crew selected for flap 40 landing.

The aircraft was stabilized by 1000 feet AGL. Thereafter, the speed started decreasing and at 621 feet AGL, the speed of the aircraft was reduced to 141 knots for which co-pilot called out for “Speed” and the PIC corrected it by increasing power. The PIC disengaged Autopilot/Auto-throttle at about 500 feet and started flying manually after establishing visual contact with runway. The speed kept on increasing and at around 450 feet AGL, the co-pilot again called out “speed” as the speed was higher than the prescribed limit to meet the stabilized criteria. The aircraft was 99 feet AGL and was not stabilized while overflying threshold runway 24. However, the PIC still continued landing even after the co-pilot called out that they are too high and they should “Go Around”. PIC was trying to maintain the rate of descent by maintaining high power settings to meet the stabilized criteria. The PIC who had already carried out a “go around” during the first approach, and since the aircraft was stabilized at 1000 feet & 500 feet could have prompted him to continue the approach even in adverse situation for landing and not to carry out another “Go Around”.

The flaring was initiated at 16 feet, however, there was no significant change in pitch and as the speed of the aircraft was still high it floated for 07 seconds before making a delayed touch down. The spoilers/speed brakes were deployed immediately after touchdown, however, as the PIC was not committed for landing, the thrust reversers were deployed only after 17 seconds of touchdown which further aggravated the situation. The Autobrakes were not selected and crew applied manual braking only after 07 seconds of touchdown and attained maximum value in 13 seconds of touchdown. Further, as the end of the runway was reported to be wet, the aircraft could not decelerate effectively.

As calculated earlier with maximum manual braking, the aircraft required 1084 meters (3555 feet) to 1526 meters (5006 feet) length of runway to land. The aircraft had already consumed 902 meters (2959 feet) of the runway before touchdown and only 1428 meters (4685 feet) of runway length was available for landing. With the circumstances discussed above, the runway length available after touchdown was not sufficient to stop the aircraft within runway. The PIC thereafter deliberately turned the aircraft to right and exited the paved surface from Taxiway ‘E’ intersection before coming to its final halt on the unpaved surface.

### **3. CONCLUSION**

#### **3.1 FINDINGS**

##### **3.1.1 General**

1. The Certificate of Airworthiness, Certificate of Registration and Airworthiness Review Certificate of the aircraft were valid on the date of incident.
2. Both pilots were qualified to operate the flight.
3. The pre-flight & post flight BA tests of the crew were found to be negative.
4. The crew carried out “Go-around” due to GPWS “Glide slope” warning during the first approach.
5. ATC tower reported end of the runway 24 as wet and gave landing clearance to the aircraft with winds as 020°/07 knots. However, during final approach tower reported winds as 010°/10 knots. The wind components were within the acceptable limits.
6. During the second approach, the aircraft was stabilized at 1000 feet AGL.
7. The crew carried out landing checklist and selected flap 40 for landing.
8. At 621 feet AGL, the co-pilot called out “Speed” as the speed of the aircraft reduced to 141 knots. The PIC called out “Correcting” and increased the speed by increasing power.
9. The PIC disengaged Autopilot/Auto-throttle at about 500 feet and started flying manually.
10. At around 450 feet, the co-pilot again called out “speed” as the speed was raised to 153.3 i.e. higher than allowable value of 153 knots ( $V_{app40} = 143 \text{ knots} + 10 \text{ knots}$ ), which was a significant deviation from the stabilized criteria.
11. The average speed during the final approach was above 153 knots.
12. The aircraft was high and was not stabilized after 500 feet till touchdown. It was at 99 feet AGL while overflying threshold of runway 24 with a speed of 156 knots. At this point, the co-pilot also called out that they are too high and they should “Go Around”. However, the PIC did not carry out “go around” and continued the approach for landing which was non-adherence to the laid down SOP.
13. The PIC had already carried out a “go around” during the first approach. Since the aircraft was stabilized by 1000 feet & also at 500 feet, this could have prompted him to continue the approach even in adverse situation for landing and not to carry out another “Go Around”.

14. The PIC initiated flare at 16 feet, however, due to high speed, it floated for 07 seconds before touch down at 902 meters (2959 feet) ahead of runway 24 threshold, which was well ahead of the touch down zone.
15. The PIC was indecisive of whether to continue the landing or “Go Around” due to which he delayed in deploying the thrust reversers. The Thrust Reversers were deployed only after 17 seconds of touchdown after co-pilot called out for the same which further aggravated the situation.
16. The PIC did not select Autobrakes and applied manual braking only after 07 seconds of touchdown and maximum brake pressure was attained after 13 seconds of touchdown.
17. As the end of runway was reported to be wet and there was considerable delay in application of wheel brakes and deployment of the thrust reversers, the aircraft could not decelerate effectively. Only 1428 meters (4685 feet) of runway length was available for landing which was not sufficient to stop the aircraft within runway.
18. As the runway end was approaching, the PIC deliberately turned the aircraft to right and it exited the paved surface from Taxiway ‘E’ intersection before coming to its final halt on the unpaved surface 80 meters away from runway edge.
19. The PIC immediately informed ATC that the aircraft had crossed the runway and is on unpaved surface.
20. PIC requested ATC for assistance for disembarkation only without actually analyzing the situation inside and outside the aircraft.
21. The crew carried out after shutdown and secure checklist.

### **3.1.2 Aircraft Operator**

1. There is no specific procedure in place for abnormal situations such as runway excursion/overshoot etc. which crew members need to follow to ensure overall safety of the aircraft without delay.
2. Tailwind landing training was not part of initial & recurrent training program.

### **3.2 PROBABLE CAUSE OF THE INCIDENT**

The incident occurred due to un-stabilized final approach and extended flare over runway which resulted in delayed touchdown and aircraft not stopping within runway.

### Contributory Factors

- Indecision of whether to continue landing or “Go-around” resulting in delayed usage of wheel brakes and deployment of Thrust Reversers.
- Continuing descent and not initiating “Go – around” when the aircraft was “un-stabilized” during final approach.

## **4. SAFETY RECOMMENDATIONS**

### **4.1 DGCA**

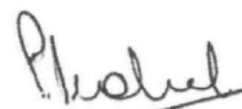
- 4.1.1 It is recommended that DGCA may advise all airline operators to formulate specific procedures for the crew members to be followed in abnormal situations like runway excursion/overshoot etc. so as to ensure overall safety of the aircraft.
- 4.1.2 It is recommended that DGCA may issue instructions to all airline operators to include runway excursion prevention program in flight crew training.

### **4.2 Aircraft Operator**

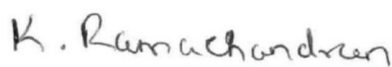
- 4.2.1 It is recommended that Tailwind landing and Balked landing be included in initial and recurrent training programme.
- 4.2.2 It is recommended that Operator may counsel their cockpit crew members to give more emphasis on Duties & Responsibilities of Pilot Flying & Pilot Monitoring.
- 4.2.3 It is recommended that Operator may develop a just and non-punitive culture to encourage flight crew to “go around” in case of safety issues at any phase of final approach (even after the Minimums).



(Kunj Lata)  
Investigator



(Capt. Priti Kohal)  
Investigator



(K Ramachandran)  
Investigator – In - Charge

Date: 24<sup>th</sup> April 2020

Place: New Delhi