FINAL INVESTIGATION REPORT

ON

SERIOUS INCIDENT TO M/S SPICEJET PVT. LTD.

BOEING 737-800 AIRCRAFT VT-SGJ

AT SHIRDI ON 29TH APRIL 2019.

K. Ramachandran
Investigator -In- charge

Amit Kumar
Investigator

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
CMM	Component Maintenance Manual
CPL	Commercial Pilot License
DGCA	Directorate General of Civil Aviation
FAF	Final Approach Fix
F/O	First Officer
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
FCU	Flight Control Unit
FMC	Flight Management Computer
FRTOL	Flight Radio Telephone Operators License
hrs	Hours
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
LLZ	Localizer
METARs	METeorological Aerodrome Reports
MLG	Main Landing Gear
MTOW	Maximum Take Off Weight
NDB	Non-Directional Beacon
NLG	Nose Landing Gear
NPA/PAR	Non – Precision Approach/ Precision Approach Radar
PIC	Pilot in Command
QRH	Quick Reference Handbook
RA	Radio Altitude
RESA	Runway End Safety Area
ROD	Rate of Descent
R/T	Radio Telephony
SB	Service Bulletin
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Range
UTC	Coordinated Universal Time

FINAL INVESTIGATION REPORT ON SERIOUS ACCIDENT OF M/S SPICEJET LIMITED B737-800 AIRCRAFT VT-SGJ AT SHIRDI ON 29th APRIL 2019.

1.	Aircraft	Type	B737-800
		Nationality	Indian
		Registration	VT-SGJ
2.	Owner & Operator		SpiceJet Limited
3.	Pilot		ATPL Holder
	Extent of Injuries		Nil
4.	Co- Pilot		CPL Holder
	Extent of Injuries		Nil
5.	No. of Passengers on board		194
6.	Date & Time of Serious Incident		29th April 2019 at 1053 UTC
7.	Place of Serious Incident		Shirdi Airport
8.	Co-ordinates of Serious Incident Site, AMSL		Lat: 19°41'27.33" N Long: 74°22'18.35" E.
9.	Last point of Departure		Delhi Airport
10.	Intended landing place		Shirdi Airport
11.	Type of Operation		Scheduled Operation
12.	Phase of operation		Landing Roll
13.	Type of Serious Incident		Runway Excursion

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

SYNOPSIS

On 29th April 2019, M/s SpiceJet Ltd. Boeing B737-800 aircraft VT-SGJ while operating a scheduled flight from Delhi to Shirdi was involved in a Serious Incident involving runway overshoot while landing at Shirdi airport.

The aircraft was under the command of an ATPL holder who was Pilot Flying (PF) with a CPL holder co-pilot who was Pilot Monitoring (PM). There were 194 passengers on board the aircraft and 04 cabin crew members.

The aircraft took-off from Delhi airport and the flight en-route Shirdi was uneventful. The aircraft was given clearance by ATC, Shirdi for landing on runway 09. The aircraft was high on approach and made a delayed touch down after more than half of the runway length. After the touchdown, the PF applied brakes but the aircraft didn't stop and overshot the runway from Runway 09 end (Runway 27) and came to rest in unpaved surface at a distance of about 160 m from runway 27 threshold.

Director General, AAIB appointed Sh. K Ramachandran, Assistant Director, AAIB as Investigator – In – Charge & Sh. Amit Kumar, Safety Investigation Officer, AAIB as Investigator to investigate into the probable cause(s) of the serious incident, vide Order No. INV.12011/11/2019-AAIB dated 2nd May 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 incident flight, the aircraft had operated sector Ahmedabad – Delhi – Pune – Delhi. There was no abnormality reported on the aircraft. Thereafter, the aircraft was scheduled to operate sector Delhi – Shirdi. 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 the incident flight.

The aircraft took-off from Delhi at 0915 UTC. The en-route flight was uneventful. The aircraft came in contact with Shirdi ATC at 1035 UTC. The crew requested for the sequence for landing for which the ATC informed that the aircraft is number 3 in sequence. Initially the aircraft was assigned runway 27 for landing. The crew carried out an orbit at 10 miles from Shirdi. The crew then informed ATC that they will be able to land on runway 09. Later, the ATC informed winds as 290^{o}/04 knots and asked the crew if runway 09 is acceptable for landing. The crew confirmed the same. At 1048 UTC, while approaching 5100 ft, the crew asked ATC for further descent for circuit altitude and the ATC cleared the aircraft for further descent on its own discretion under Visual Metrological Condition (VMC). The crew also requested for long finals for landing for which the ATC affirmed.

The crew descended the aircraft to circuit altitude of 3500 feet and carried out a circuit to line up runway 09 for landing. At 1051 UTC, after sighting the aircraft the ATC gave landing clearance to the aircraft and informed winds as 320^{o}/05 kts. The crew carried out landing checklists but did not discuss go around procedure. The PF disconnected autopilot and auto-throttle at approximately 1000 feet and started manual descent. At this point of time, the aircraft was not stabilized and was high on approach. As per the statement of PF he observed 03 white and 01 red on PAPI and increased the rate of descent in order to stabilize the aircraft. However, the aircraft was still high on approach and was not stabilized at 500 feet and below. The aircraft was about 120 feet AGL when it was overflying the runway 09 threshold. The aircraft floated above the runway and made a delayed touchdown. The aircraft landed at 1053 UTC and touchdown was almost abeam ATC tower. Immediately after touchdown, the PF realized that they have already consumed half of the runway during flare and they have to stop the aircraft well within the remaining length. So, the PF disconnected auto brakes and started applying brakes

manually but did not call out the same. The PF applied maximum pressure to stop the aircraft but it did not stop and overshot the runway from runway 27 side. After exiting the runway, the aircraft continued on the unpaved surface before coming to the final halt at around 160 meters from runway 27 threshold.

After observing lot of dust emanating near the runway 27, the ATC asked the crew to confirm if all operations are normal for which the crew replied all operations normal. The ATC then asked them to backtrack and vacate the runway. As per the statement of the crew after the aircraft stopped on the unpaved surface, they tried to move the aircraft by increasing power, however, it did not move.

At 1053 UTC, the ATC advised fire tender to proceed to the aircraft. At 1055 UTC, the crew reported to ATC that they are unable to backtrack and requested for tow tractor. Thereafter, the operational jeep entered the runway and reported ATC that the aircraft is out of the runway. The operational jeep also reported that there is no damage to the aircraft and the engines were still running. At 1101 UTC, the crew also reported to ATC that the aircraft had crossed the runway and was stuck on gravel after it was asked to confirm the position of aircraft by the ATC. The ATC then advised the crew to switch off the engines. The crew then switched off the engines, after 10 minutes of coming to its final halt.

The passengers were disembarked normally with the help of a step ladder. 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.

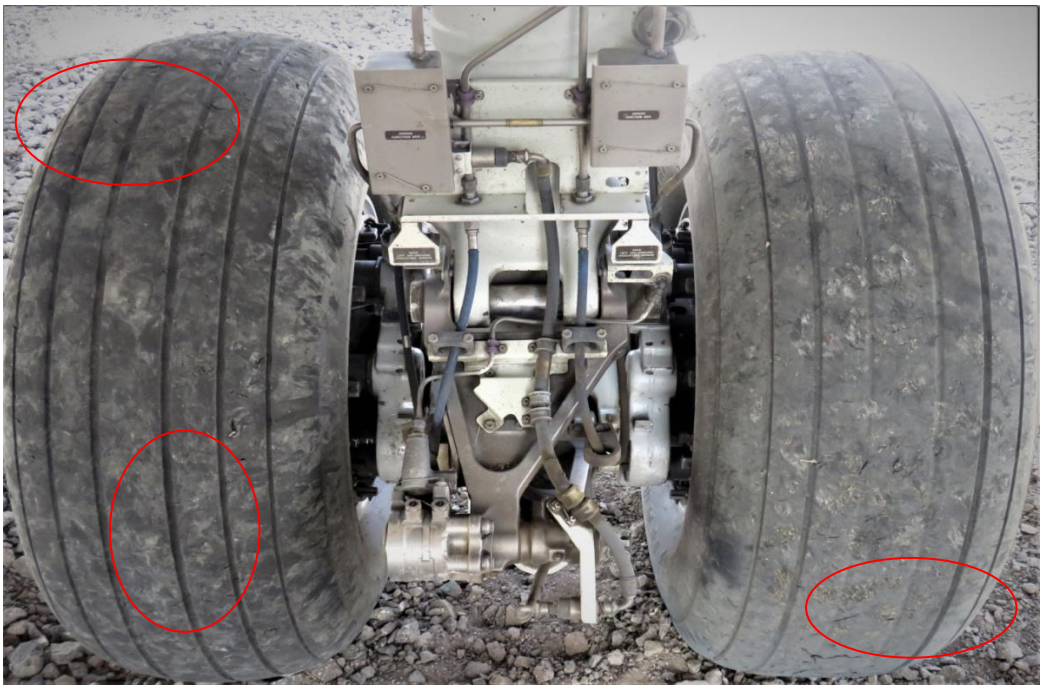
1.2 INJURIES TO PERSONS

Injuries	Crew	Passengers	Others
Fatal	NIL	NIL	NIL
Serious	NIL	NIL	NIL
~~**Minor**~~**/ None**	02+04	194	

1.3 DAMAGE TO AIRCRAFT

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

1. Multiple small cuts in all tyres of NLG and MLG were found and ingress of dust into all brake units was also found.



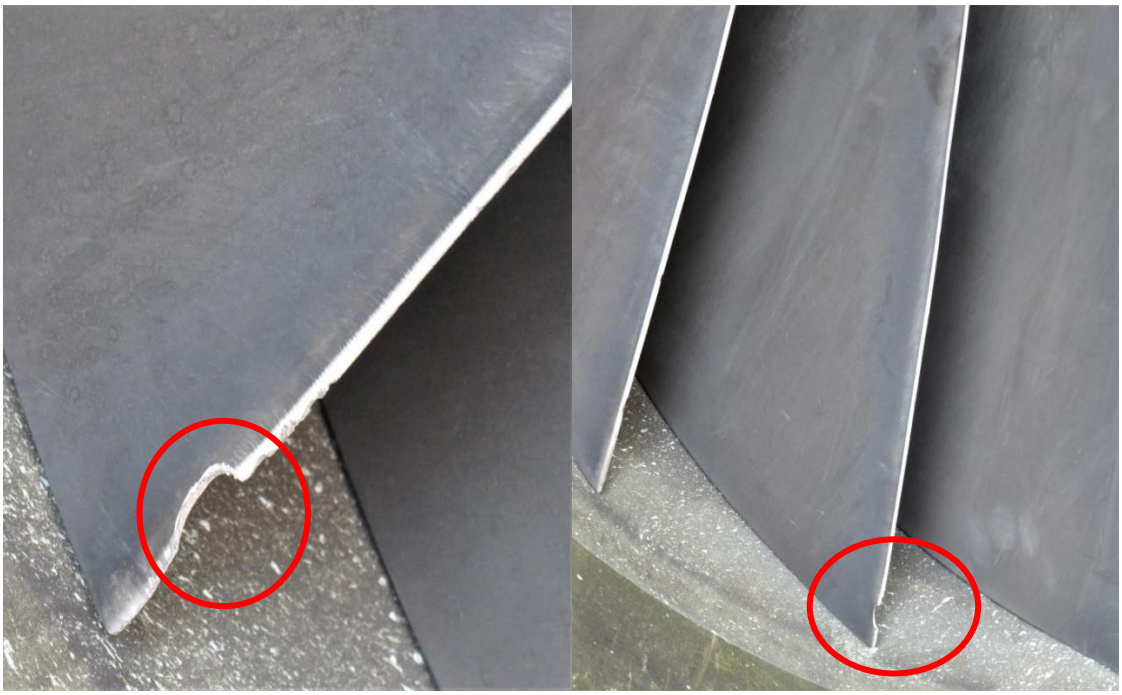
Pic 1: Cut marks on MLG tyres.

Pic 2: Cut marks on NLG Tyres.

2. Roll Attitude Indicator glass was found broken.

Pic 3: Damaged Roll Attitude Indicator

3. Minor distortion was observed on leading edge of blade No. 19 of LH engine.
4. On RH engine, missing material found on blades No. 12 & 14. On blade No.14 missing material of dimension L=1.5 cm & W=0.5 cm located 1.2 cm below the tip. Blade No.12 missing material of dimension L=1.8 cm & W = 0.6 cm located 2.5 cm below the tip. Both were found out of AMM limits.



Pic 4: Engine Fan Blade Damages.

1.4 OTHER DAMAGE

Nil

1.5 PERSONNEL INFORMATION

1.5.1 Pilot – In – Command

Date of Birth	22/09/1984
License	ATPL
Date of Issue	02/07/2013
Valid up to	01/07/2020
Category	Aeroplane
Date of Class I Med. Exam.	31/12/2018
Class I Medical Valid up to	07/01/2020
Date of issue FRTOL License	04/08/2008
FRTO License Valid up to	03/08/2023
Endorsements as PIC	B737-700-700F-800-900-MAX
Total flying experience	8170 hrs. 40 min
Total flying experience on type	7921 hrs. 46 min
Last Flown on type	28/04/2019
Total flying experience during last 1 year	780 hrs. 32 min
Total flying experience during last 6 Months	395 hrs. 55 min
Total flying experience during last 30 days	71 hrs. 59 min
Total flying experience during last 07 Days	23 hrs. 53 min
Total flying experience during last 24 Hours	2 hrs. 37 min
Rest period before flight	22 hrs.
Whether involved in Accident/Incident earlier	No
Date of latest Flight Checks and Ground Classes	01/03/2019 (sim) 20/07/2018. (aircraft) and 06/12/2018 (ground classes)

The PIC was the pilot flying. He joined the company in the year 2009. He had operated into Shirdi earlier. Prior to the incident flight, he had operated into Shirdi on 14th April 2019.

He had carried out “Go Around” only once in his entire flying and that was due to ATC instructions.

1.15.2 Co-Pilot

Date of Birth	15-02-1989
License	CPL
Date of Issue	17-08-2009
Valid up to	16-08-2019
Category	Aeroplane
Date of Class I Med. Exam.	28-08-2018
Class I Medical Valid up to	06-09-2019
Date of issue FRTOL License	17-08-2009
FRTO License Valid up to	16-08-2019
Endorsements as PIC	Cessna 152 A, Piper Seneca PA -34
Total flying experience	460 hrs 34 min
Total flying experience on type	206 hrs 55 min
Last Flown on type	29th April,2019
Total flying experience during last 1 year	206 hrs. 55 min
Total flying experience during last 6 Months	206 hrs. 55 min
Total flying experience during last 30 days	60 hrs. 20 min
Total flying experience during last 07 Days	11 hrs. 54 min
Total flying experience during last 24 Hours	01 hour 55 min
Rest period before flight	24 hrs.
Whether involved in Accident/Incident earlier	No
Date of latest Flight Checks and Ground Classes	23-02-2019 and 05-09-2018

The co-pilot was the Pilot Monitoring. He joined the company in July 2018 and started flying as co-pilot from February 2019.

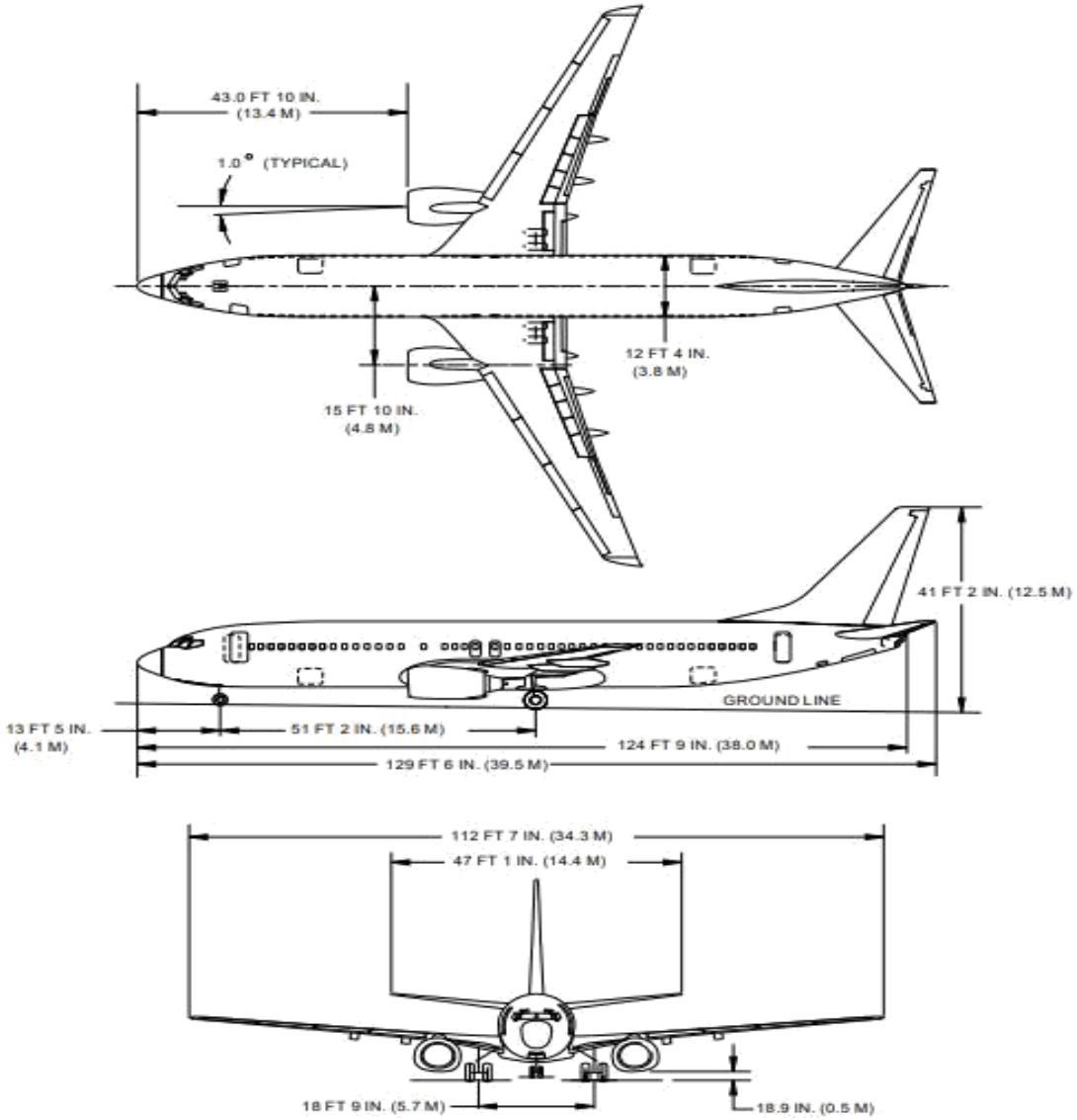
Both crews were paired for the first time. None of them were involved in Accident/serious incident earlier.

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 5: Three View diagram of Boeing 737-800 aircraft

1.6.1.1 Brake System

There are three hydraulic systems viz main, alternate and standby for the purposes of operation of various systems and controls including brakes. 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-SGJ General Information

Aircraft Model	Boeing 737-800
Aircraft S. No.	29641
Year of Manufacture	2005
Name of Owner	AVIATOR ML 29641 LIMITED

C of R	4146/3
C of A	6255/2
Category	NORMAL
C of A Validity	N/A ARC validity (31-Mar-2020)
ARC issued on	29-Mar-2019
ARC valid up to	31-Mar-2020
Aircraft Empty Weight	41877.20 Kg.
Maximum Take-Off Weight	79015 Kg.
Date of Aircraft weighment	18-May-2018
Empty Weight	41877.20 Kg.
Max Usable Fuel	22137 Kg.
Max Payload with full fuel	13944.80 Kg.
Empty Weight C. G	658.79 Inch (16.73 meter) aft of datum. (CG = 20.34 % MAC)
Next Weighing due on	17-May-2023
Total Aircraft Hours	49005:12
Last major inspection	19-May-2018
Engine Type	CFM56-7B24
Date of Manufacture LH	02-03-2006
Engine Sl. No. LH	892809
Last major inspection (LH)	16-Jan-2018
Repairs carried out after last major inspection till date of incident	NIL
Total Engine Hours/Cycles LH	38942/27660
Date of Manufacture RH	27-01-2005
Engine Sl. No. RH	892273
Last major inspection (RH)	30-Apr-2018
List of Repairs carried out after last major inspection till date of incidence	NIL
Total Engine Hours/Cycles RH	46434/25031
Aero mobile License	No. A-010/0250-RLO (NR) issued on 17-Feb-2011

All concerned Airworthiness Directives, mandatory Service Bulletins, and DGCA Mandatory Modifications on this aircraft and its engines were 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 incident flight. The last snag recorded was on 24th April 2019 and the snag was "Anti-Skid INOP light in climb, illuminated in cruise antiskid extinguished in descent". The rectification action was carried out satisfactorily and the aircraft was released for further flights.

"Load And Trim" sheet of the accidented flight was prepared and center of gravity was found within limit.

The wheels and brake assemblies installed on the incident aircraft were overhauled at M/s Magnum Aviation Pvt. Ltd. which is a DGCA approved Shop.

1.7 METEOROLOGICAL INFORMATION

METARs – Shirdi International Airport from 1000 UTC to 1130 UTC

Time in UTC	Wind Dir	Wind Speed (Knots)	Vis (m)	Clouds	Temp (°C)	Dew Point	QFE hPa	QNH hPa	TREND
1000	330	04	6000	NSC	42	08	940	1008	No SIG
1030	300	07	6000	NSC	41	08	939	1008	No SIG
1100	290	06	6000	NSC	42	09	939	1007	No SIG
1130	310	07	6000	NSC	41	12	939	1007	No SIG

1.8 AIDS TO NAVIGATION

The Shirdi Airport has got only one runway and is a "Visual Approach Runway" which is equipped with only "PAPI". There is a "Wind Sock" installed on runway 27 side.

1.9 COMMUNICATIONS

At the time of incident, the aircraft was in contact with Shirdi ATC on frequency 118.45MHz. There was always two-way communication between the aircraft& ATC.

Following are some salient transcripts of ATC tape: -

Time	**Transmitted by**	**Description**
10:35:36	SEJ946	SHIRDI SPICEJET NINER FOUR SIX
10:35:38	TOWER	SPICEJET NINER FOUR SIX SHIRDI TOWER
10:35:40	SEJ946	CONFIRM OUR SEQUENCE IN SHIRDI SIR
10:35:44	TOWER	NUMBER THREE IN SEQUENCE
10:42:14	SEJ946	SPICEJET NINER FOUR SIX CONFIRM MAY WE ORBIT AT ONE ZERO MILES

10:42:17	TOWER	SPICEJET NINER FOUR SIX EXPECT JOINING RIGHT DOWNWIND RUNWAY TWO SEVEN
10:42:23	SEJ946	ROGER SIR RIGHT DOWNWIND RUNWAY TWO SEVEN SPICEJET NINER FOUR SIX
10:43:56	SEJ946	AND SIR SPICEJET NINER FOUR SIX WE ARE ABLE RUNWAY ZERO NINER
10:44:01	TOWER	ROGER
10:44:52	TOWER	SPICEJET NINE FOUR SIX MAKE AN ORBIT OVERHEAD AIRFIELD AT SIX THOUSHAND FEET.
10:44:57	SEJ946	AN ORBIT OVERHEAD SPICEJET NINE FOUR SIX CONFIRM LEFT OR RIGHT.
10:45:02	TOWER	LEFT
10:45:03	SEJ946	ROGER
10:48:01	TOWER	SPICEJET NINE FOUR SIX TOWER OBSERVED WIND IS TWO NINE ZEO DEGREE ZERO FOUR KNOT CONFIRM RUNWAY ZERO NINE ACCEPTABLE.
10:48:08	SEJ946	AFFIRM SIR
10:48:11	TOWER	ROGER REPORT JOINING LEFT DOWNWIND RUNWAY ZERO NINE.
10:48:14	SEJ946	CONFIRM WE CAN TAKE LONG FINAL
10:48:18	TOWER	AFFIRM
10:48:19	SEJ946	THANK YOU
10:51:16	SEJ946	WE HAVE LONG FINAL RUNWAY ZERO NINER
10:51:18	TOWER	SPICEJET NINE FOUR SIX IN SIGHT CLEAR TO LAND RUNWAY ZERO NINER WIND THREE TWO ZERO DEGREE ZERO FIVE KNOTS.
10:51:23	SEJ946	CLEARED TO LAND RUNWAY ZERO NINER SPICEJET NINER FOUR SIX
10:53:26	TOWER	SPICEJET NINE FOUR SIX TOWER
10:53:28	SEJ946	GO AHEAD SPICEJET NINER FOUR SIX
10:53:30	TOWER	CONFIRM ALL OPERATIONS NORMAL
10:53:33	SEJ946	ALL OPERATIONS NORMAL
10:53:36	TOWER	CONFIRM BACKTRACK AND VACATE VIA ALPHA
10:53:38	SEJ946	BACKTRACK AND VACATE VIA ALPHA SPICEJET NINE FOUR SIX
10:54:16	SEJ946	SPICEJET NINER FOUR SIX UNABLE TO BACKSTRACK
10:54:18	TOWER	SPICEJET NINER FOUR SIX HOLD AT PRESENT POSITION

10:54:20	TOWER	HOLD AT PRESENT POSITION SPICEJET NINER FOUR SIX
10:54:25	TOWER	CONFIRM ALL OPERATIONS NORMAL
10:54:28	SEJ946	ALL OPERATIONS NORMAL SPICEJET NINER FOUR SIX
10:54:32	TOWER	CONFIRM ANY ASSISTANCE REQUIRED
10:54:36	SEJ946	REQUEST TOW TRACTOR SPICEJET NINER FOUR SIX
10:54:38	TOWER	ROGER HOLD AT PRESENT POSITION
10:54:40	SEJ946	HOLD AT PRESENT POSITION SPICEJET NINER FOUR SIX
10:55:20	TOWER	SPICEJET NINER FOUR SIX OPERATIONAL JEEP IS ENTERING VIA TAXIWAY BRAVO AND PROCEEDING NEAR THE AIRCRAFT EXERCISE CAUTION
10:56:57	TOWER	SPICEJET NINER FOUR SIX HOLD AT PRESENT POSITION WE ARE COORDINATING.
10:57:02	SEJ946	HOLDING POSITION SPICEJET NINER FOUR SIX
11:00:11	TOWER	SPICEJET NINER FOUR SIX SHIRDI TOWER
11:00:13	SEJ946	GO AHEAD SPICEJET NINER FOUR SIX
11:00:15	TOWER	SPICEJET NINER FOUR SIX CONFIRM AIRCRAFT STUCK ON STRIP OF RUNWAY
11:00:30	SEJ946	ON THE GRAVEL SPICEJET NINE FOUR SIX
11:00:34	TOWER	SPICEJET NINER FOUR SIX SAY AGAIN
11:00:35	SEJ946	SIR IT CROSSED RUNWAY ON THE GRAVEL NOW
11:00:39	TOWER	ROGER
11:02:30	TOWER	SPICEJET NINER FOUR SIX SHIRDI TOWER
11:02:32	SEJ946	GO AHEAD SIR
11:02:34	TOWER	CONFIRM YOU CAN SWITCH OFF THE ENGINE NOW
11:02:36	SEJ946	AFFIRM SIR WE CAN SWITCH OFF.
11:02:38	TOWER	ROGER SWITCH OFF THE ENGINE
11:02:39	SEJ946	THANK YOU

1.10 AERODROME INFORMATION

1.10.1 Shirdi Airport is operated by Maharashtra Airport Development Company Ltd. (MADC) and AAI maintains Communication, Navigation and Surveillance (CNS) & Air Traffic Management (ATM) services at the airport. The Shirdi Aerodrome was licensed by DGCA on 21st September, 2017 and present runway is capable of handling Code 3C type aircraft.

The IATA Location Identifier Code is SAG and ICAO Location Indicator Code is VASD. Shirdi Airport operates as domestic airport under VFR condition and night operation is not permitted. The Airport Rescue and Fire Fighting Services is Category '6' and provided by MADC. Precision Approach Path Indicator (PAPI) are available at both ends.

Airport Co-ordinates: - Lat: 19°41'27.33" N

Long: 74°22'18.35" E.

Elevation: 1908.60 feet (581.75 meters).

The orientation of the runway is 09/27. Taxiing guidance provided on R/T by ATC as Visual Docking Guidance System (VDGS) is not available.

The detail of runway distances is as below;

Runway	**TORA(M)**	**TODA (M)**	**ASDA (M)**	**LDA (M)**	**WIDTH (M)**	**RESA (M)**
09	2500	2500	2500	2500	45	240 x150
27	2500	2500	2500	2500	45	240 x150

Taxiway A and B are parallel to each other and view of ATC tower is hindered because of three antenna poles.

Last "friction test" for runway surface at Shirdi airport was carried out on 24.08.2018 and was within the limits.

The ground calibration of "PAPI" at runway 09 and 27 side was carried out on 16.04.2019 and was found satisfactory.

There was a considerable delay in providing requisite services for disembarkation of the passengers.

1.10.2 The investigation team visited the Aerodrome & ATC tower on 30.04.2019 i.e. the day after the incident. During the visit following observations were made: -

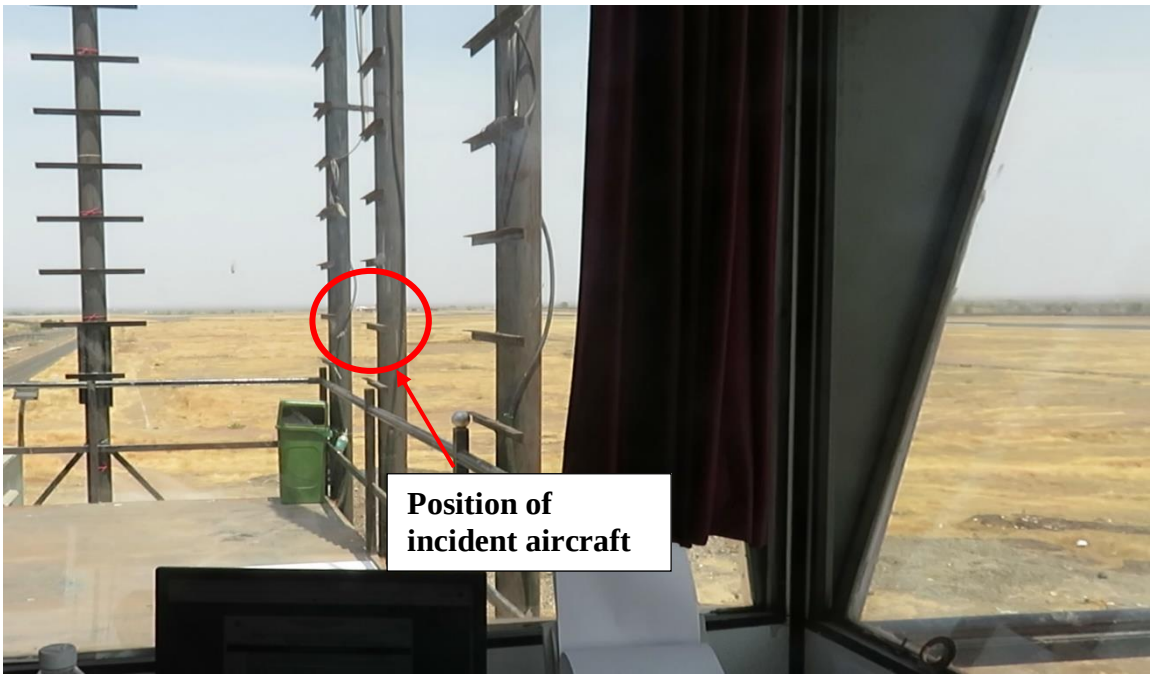
i. Visual Wind Direction Indicator was blocked by the ATC building structure.
ii. Digital Wind Indicator in front of controller was not clear.

Pic 6: Digital Wind Indicator in front of controller

iii. Scientific assistance (MET) digital readout had incorrect runway direction from source.

iv. Both runways 09 & 27 were used for operations, but the "Digital Current Weather Indicator" system was located only on the 27 side and the only "Wind Sock" was also located on the same side.

v. The runway 27 side is not clearly visible from the ATC tower, i.e. though the aircraft is visible, but the controller cannot observe the position of the aircraft on ground when it is on runway 27 side.



Pic 7: View of Runway 27 side from ATC.

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

A total of last 02:04:13 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 Shirdi Tower at 103536 UTC and co-pilot asks about their sequence for landing for which the Tower informs number three in sequence.
- At 104144 UTC, Co-pilot was heard discussing with PIC that they are very high (on approach) and asks PIC what to do now. PIC tells we are still at 10 miles.
- At 104214 UTC, PIC confirms with tower, if they can carry out an orbit at 10 miles for which the tower confirms and replies expect joining right downwind runway 27.
- At 104356 UTC, PIC informs tower that will be able to land on runway 09 for which the tower affirms.
- At 104452 UTC, tower asks crew to make an orbit (left) over airfield at 6000 feet.
- At 104801 UTC, tower informs crew about the winds as 290^{o}/04 knots and asks to confirm if runway 09 is acceptable. The PIC affirms the same and asks tower if they can take long final for approach for which the tower affirms.
- At 105116 UTC, the co-pilot informs tower that they are at long finals for runway 09. The tower informs crew that the aircraft is in sight and gives the landing clearance for runway 09 and informs winds as 320^{o}/05 knots.
- 105120 UTC – 105202 UTC – Crew was heard carrying out landing checklists.
- At 105204 UTC, Auto Call Out of "Approaching Minimums" was heard in the cockpit.
- At 105208 UTC, co-pilot calls out "500, tail wind 16 knots….".
- At 105210 UTC, Auto Call out of "500" was heard along with co-pilot calling out "little high sir".
- At 105234 UTC, Auto Call out of "50…40…30…20….10 was heard in the cockpit.

- At 105244 UTC, the aircraft touch down (thud) sound was heard.
- At 105249 UTC, the co-pilot was heard saying "confirm sir, manual braking…..reversers…speed brakes up".
- At 105301 UTC, the sound of aircraft entering the unpaved surface was heard.
- At 105312 UTC, the aircraft stops with a continuous BEEP sound heard in the cockpit with co-pilot calling out "out of the runway".
- At 105320 UTC, tower calls and confirms if all operations are normal for which the co-pilot immediately responds with "All operations Normal" as conveyed by PIC. The tower then instructs to backtrack and vacate runway.
- At 105343 UTC, the co-pilot tells PIC that we will not be able to backtrack.
- At 105347 UTC, the sound of engine power increasing was heard along with continuous BEEP sound in the cockpit.
- At 105404 UTC, the co-pilot tells PIC that they will need to call tow truck.
- At 105408 UTC, the PIC asks Co-pilot to convey tower that they are unable to back track. Accordingly, co-pilot informs the same to tower for which tower asks them to hold at present position.
- At 105425 UTC, the tower again confirms if all operations are normal for which the co-pilot informs all operations normal as conveyed by PIC.
- At 105432 UTC, the asks if any assistance is required for which the co-pilot replies "request tow tractor" as conveyed by PIC. The tower again instructs crew to hold at present position.
- At 105443 UTC, co-pilot was discussing with PIC about what has happened and asks PIC if he could have carried out "go-around".
- At 105520 UTC, tower informs crew that operations jeep is entering via taxiway B and proceeding near aircraft and instructs them to exercise caution.
- At 105541 UTC, the PIC asks the cabin crew to hold positions.
- At 105657 UTC, the tower asks crew to hold at present position as they are coordinating.
- At 110015 UTC, the tower asks crew to confirm if the aircraft is stuck on strip of runway for which the co-pilot informs that the aircraft nose is behind that….. on the gravel as conveyed by PIC. The tower confirms again for which the co-pilot says "it crossed the runway and, on the gravel now".

- At 110144 UTC, the PIC was heard discussing with Co-pilot about to try again for backtrack).
- At 110158 UTC, the sound of increase in engine power was heard along with continuous BEEP sound in the cockpit.
- At 110234 UTC, the tower asks crew and confirms if they can switch off the engines for which the crew affirms.
- At 110653 UTC, the cabin crew calls PIC and asks if they have to wait for another few minutes. The PIC informs that the vehicles are on the way…the passengers will be deboarded and also informs that the aircraft is out of the runway. The cabin crew confirms if a step ladder will come or otherwise, they need to deploy the slides for which the PIC replied that he will confirm what to do.
- At 110713 UTC, the recording ends.

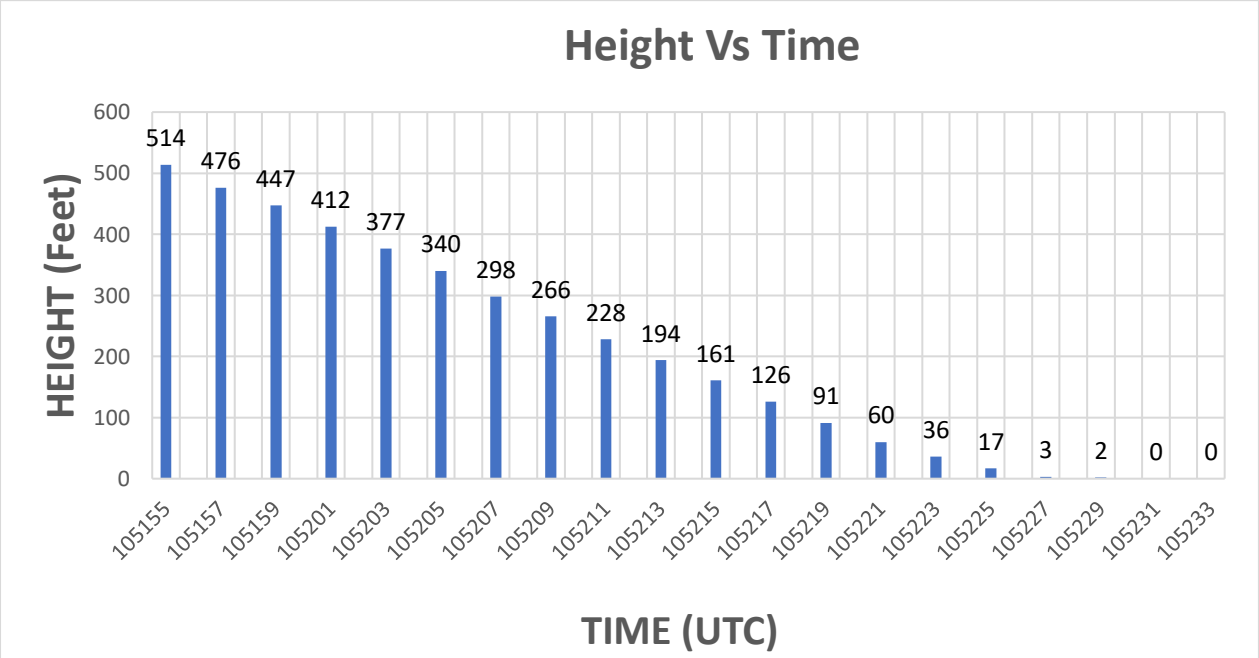
1.11.2 Digital Flight Data Recorder

- The landing gears were extended at radio height of approximately 1120 ft.
- At 105127 UTC, the autopilot was disengaged at radio height of 1043 ft, simultaneously after 2 seconds auto-throttle was also disengaged. Thereafter, the pilot started descending manually.
- At 105155 UTC, the aircraft was at height of 514 ft with ROD of 1065 ft/min, pitch of 1.9^{o} UP and Approach speed of 147 knots. Wind as per FMC was 302^{o}/20 knots, i.e. tail wind component of 17 knots.
- At 105233 UTC, the aircraft made touchdown with pitch of 1.6^{o} UP, heading 85.8, vertical acceleration of 1.41g, speed of 143 knots, flaps 30^{o}, "Auto Brakes 1" was selected, Commanded Brake Pressure left was 390 psi & Right 238 psi. The spoilers and Thrust Reversers were deployed immediately after touchdown.
- At 105237 UTC, i.e. after 04 seconds of touchdown, the pilot changed over from "Auto Brakes 1" to manual braking with speed of 123 knots, Commanded Brake Pressure Left was 1037 psi & Right was 1501 psi.
- At 105255 UTC, there was change in heading from 88.2^{o} to 85.8^{o} and kept on changing till it settled at 57^{o}.
- At 105302 UTC, i.e. 29 seconds after touchdown, the aircraft came to a final halt with heading 57^{o}, Left engine N1 27.13 & Right engine N1 28.

- At 105310 UTC, the left engine N1 was observed to be increased to 59.13 and Right engine N1 to 51.1.
- At 105350 UTC, the left engine N1 was again increased to 73.88 and Right Engine N1 to 72.8.
- At 110034 UTC, i.e. 07 minutes 32 seconds after the aircraft came to its final halt, the engines were shut down.

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

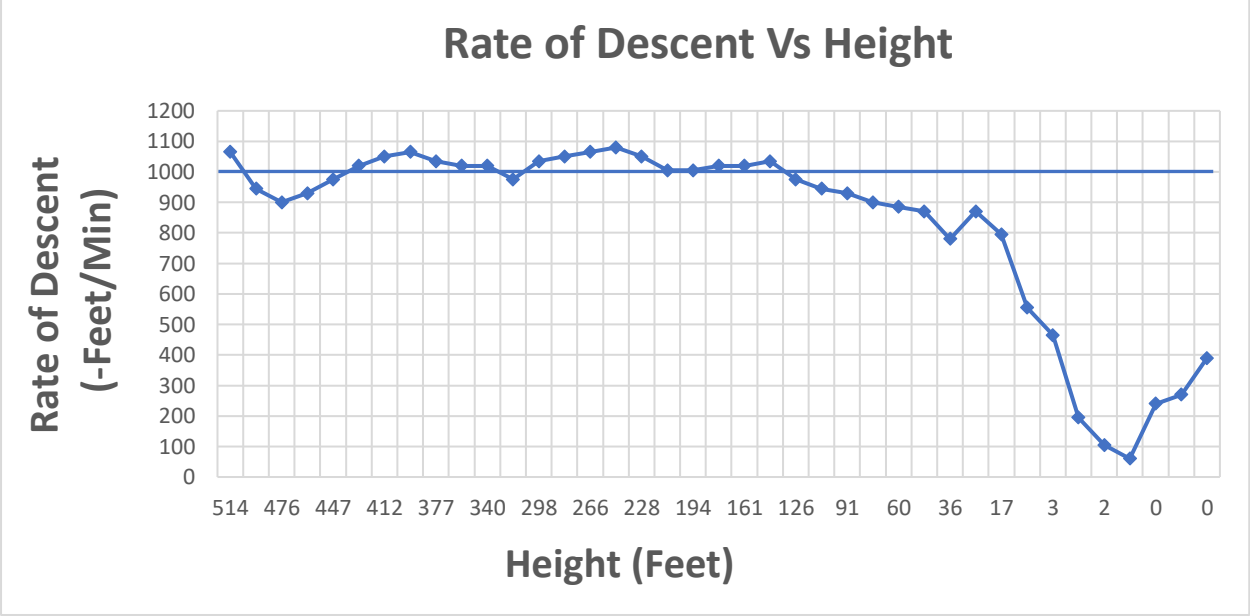
- The autopilot was disengaged at radio height of 1043 feet at 105127 UTC and the aircraft made touch down at 105233 UTC, i.e. the aircraft took 66 seconds to descent from 1043 feet to ground.
- The aircraft was at Radio height of 165 feet with Vapp of 152.8 knots and Pitch of 0.5^{o} Down while overflying runway 09 threshold.
- The aircraft rolled for a distance of about 1216 meters and for duration of 29 seconds after touchdown before coming to its final halt.



Pic 8: Graph showing Change in height with Time (500 feet to Touchdown).

- The "Reference Speed (Vref)" was calculated as 143 knots. The "Approach Speed (Vapp)" will be Vref + 5 knots i.e. Vapp of 148 knots.
- The approach speed was observed to have varied from147 knots to 155 knots from minimums (500 feet) to touchdown with 147 knots at 500 feet and 143 knots at touchdown.

- The ROD varied between 300 and 1400 ft/min from Radio height of 1011 feet (at 105133 UTC) till touchdown (at 105233 UTC) with value of 1065 ft/min at radio height of 514 feet and 390 feet/min just before touchdown.



Pic 9: Graph showing Change in Rate of Descent with height (500 feet to Touchdown).

- The pitch attitude was observed to have changed from UP position to DOWN position and vice – versa number of times ranging between 0.5° DOWN (at 105127 UTC, 1043 feet) and 3.7° UP just before touchdown. At the time of touchdown, the pitch attitude was 1.6° UP. There was sudden change in pitch from 1.2° to 2.1° at radio height of 17 feet.
- The commanded brake pressure was observed to have increased from 390 psi for LMW (Left Main Wheel) & 238 RMW (Right Main Wheel) at the time of touchdown to 3200 psi (LMW) & 3100 psi (RMW) in 13 seconds after touchdown. Sudden drop of commanded Brake pressure was observed after 17 seconds of touchdown, from 3222 psi to 810 psi for LMW and from 3090 psi to 1583 psi for the RMW. However, the commanded brake pressure of LMW was observed to have increased again but the commanded brake pressure of RMW was continuously decreasing thereafter.

1.12 WRECKAGE AND IMPACT INFORMATION

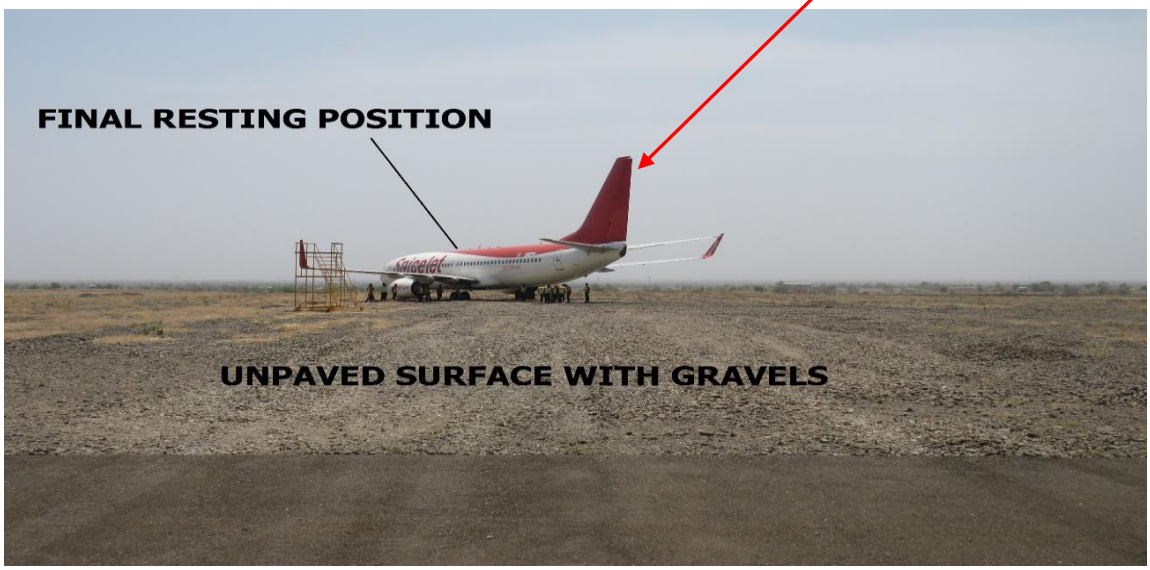
The aircraft was high on approach and made a delayed touchdown on runway abeam ATC tower at a distance of about 1445 meters ahead of runway 09 threshold. The aircraft rolled for about 1055 meters on the runway before exiting from runway 09 end (Runway

27). Tyre marks of the aircraft were observed before the runway 09 end which makes it evident due to heavy application of brakes by the crew.

Pic 10: Main Landing Gear Tyre marks on runway

The aircraft travelled for about 100 meters on the unpaved surface (which was full of gravels) before coming to its final halt. The aircraft was resting on the unpaved surface heading 57^{o}and about 14 meters to the left of runway centerline.

Pic 11: Touchdown and Final Resting Position of Aircraft.



Pic 12: Final Resting position of the aircraft.

Dents/nicks were observed on the leading edge of fan blades of engine # 2 probably due to gravels impacting the blades while the engine was running.

All switches/CBs in the cockpit were found in OFF position. All controls like aileron, rudder, etc. were at their respective 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 Analyzer Test) at Delhi before departure 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 Shirdi 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 Runway Surface Friction Testing

Runway Surface Friction Test was carried out as per DGCA's Aerodrome Advisory Circular (AD AC NO. 20 of 2017, dated 5th July 2017) in the presence of investigation team. Runway friction levels were found satisfactory as per permissible values given in table of Para 4.1 of DGCA's Aerodrome Advisory Circular (AD AC NO. 20 of 2017, dated 5th July 2017).

Design Object of Friction Level for New Surface	0.74
Maintenance Planning Level	0.47
Minimum Acceptable Friction Level	0.34
Measured friction value for the runway	**0.81(Average)**

1.16.2 Brake Assembly Functional test

All four main wheel brake assemblies were removed from the aircraft and quarantined for further examination to ascertain their serviceability. All four brake assemblies were

subjected to Functional test at a DGCA approved shop in the presence of investigating team.

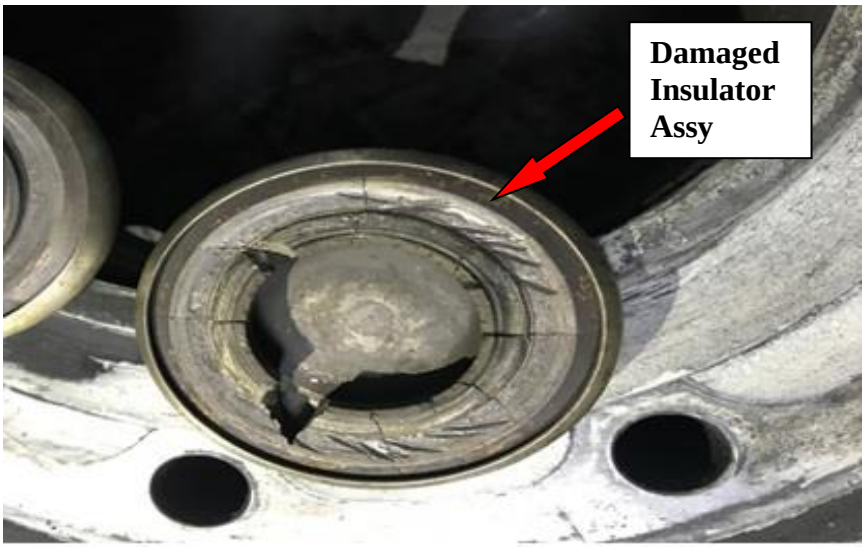
During the examination, it was observed that the brake assembly with Sl. No.3057 which was fitted at #4 wheel (outer wheel of Right MLG) and Sl. No. 4930 which was fitted at #2 wheel (inner wheel of Left MLG) didn't meet the manufacture's Standards & Specification documented in CMM. Whereas brake assembly Sl. No. 3211 fitted at #3 wheel (inner wheel of Right MLG) & 4739 fitted at #1 wheel (outer wheel of Left MLG) met the manufacture's Standards & Specification documented in CMM.

Following anomalies were observed during the functional test: -

Brake Assembly # 4, SL.No. 3057

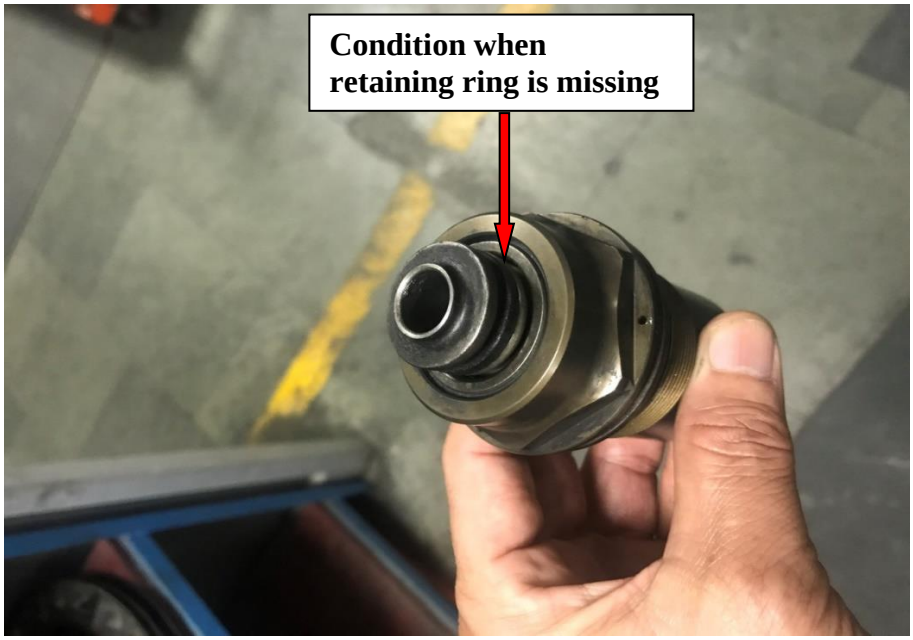
- Leakage of Hydraulic fluid observed all around thrust plate assembly and hydraulic fitting.
- 01 of grease fittings was found missing.
- 01 of the 06 Insulator assembly found damaged and disconnected from adjuster assembly, clip retainer found missing, retainer ring found missing and the guide spring was observed to have come out.

Functional test could not be performed as brake assembly was unserviceable for testing.



Pic 13: Damaged Insulator Assembly

Pic 14: Damaged Pressure Plate



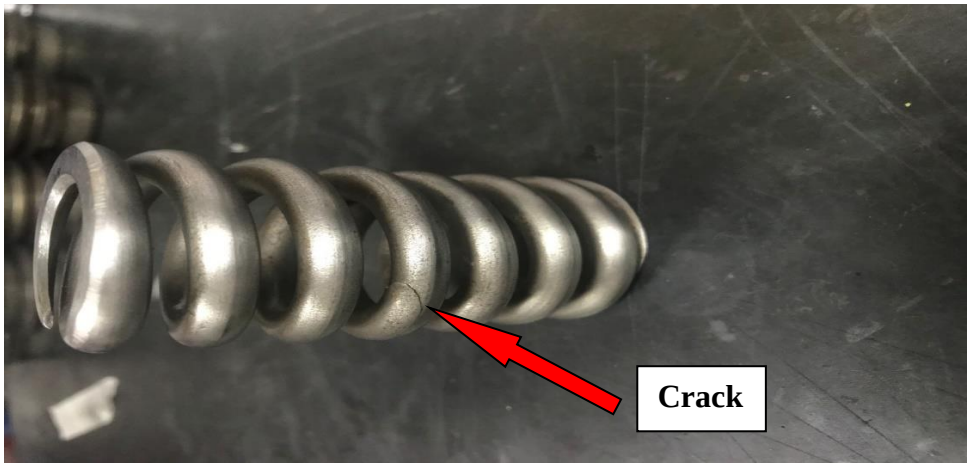
Pic 15: Retaining ring found missing in one of the insulator assembly

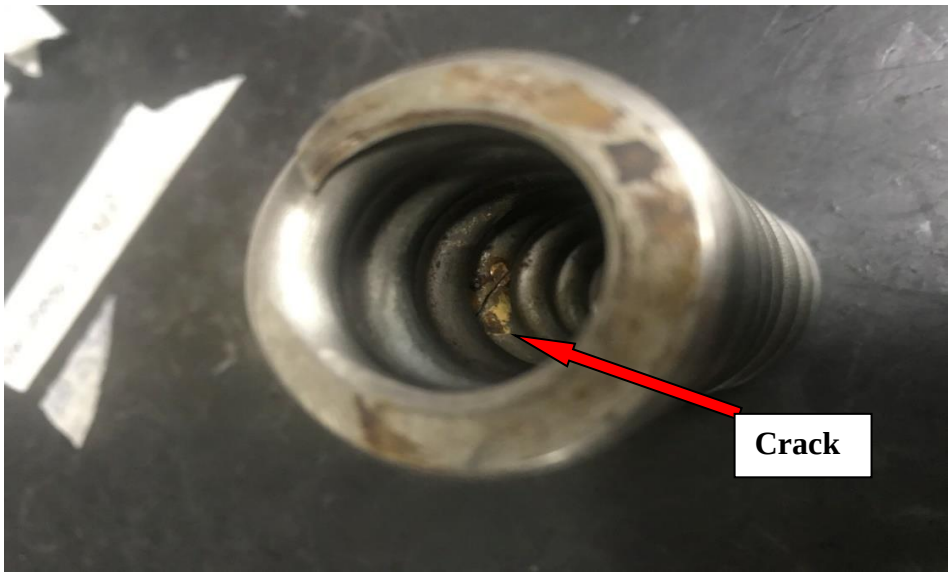
Reason: Retaining ring was either defective or not installed properly at the time of assembling the brake.

<u>Brake Assembly # 2, SL.No. 4930</u>

- No damage was observed during visual inspection.
- No leakage observed during low pressure (3-7 psi) and high pressure (3000-3050 psi) test.
- The clearance between one of the insulators and thrust plate was found to be 0.012 inch instead of minimum permissible clearance of 0.050 inch as per CMM.

- Crack was observed in the spring removed from one of the adjuster assembly where the clearance between insulator and thrust plate assembly was found to be 0.012 inch.





Pic16 &17: Crack found in the spring of one of the adjustor assembly

Reason: The spring was cracked which resulted into the less clearance.

1.17 ORGANISATIONAL AND MANAGEMENT INFORMATION

1.17.1 The aircraft was operated by a scheduled operator holding Air Operator Permit (AOP) No. S-16 in Passenger and Cargo Category which is valid till 16.05.2023. M/s SpiceJet currently has seven Boeing737-700, fifty-two Boeing 737-800, five Boeing 737-900, thirteen Boeing 737-8(MAX), Four B737-700 (Freighter), Five B737-800(Wet Lease), and thirty-two Bombardier Q400s, with a total of 118 aircraft.

The operator carries out its own maintenance as a CAR 145 approved organization. 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.

1.17.3 Landing Procedure, Techniques & Configurations

In the following paragraphs relevant portion of the Operations Manual (OM) of the Aircraft Operator are discussed to understand the standard procedures in place which has been corroborated with the present case.

1.17.3.1 Landing

The standard prerequisites for a safe landing require the runway threshold to be crossed at the correct height and airspeed, and to land on the centerline within the prescribed touchdown area.

i. A stabilized approach is the means by which this effected.
ii. A final assessment of the cross wind is needed as the aircraft crosses the threshold to ensure that the cross wind does not exceed the limit or other predetermined value prudent for the particular runway and the conditions.
iii. Excess threshold height, speed and touchdown float will significantly increase landing/ stopping distance. Specifically:
    a) The target threshold height for all aircraft is 50 ft;
    b) The maximum allowable airspeed over the threshold is Vref + 20kts*.

The approach speed which contains increments for wind speed and gust should be flown accurately on the final approach. The additional speed increments should be reduced as the threshold is crossed to within the maximum tolerance. Conditions dictate what the cushion ought to be and in a tail wind, it should be minimal.

With a 3° approach glide path and a target runway threshold height of 50 ft, the touchdown aiming point is 1,000 ft. This point can be identified from the standard runway markings.

iv. The touchdown area should be within the range of 750' to 1,250' from the runway threshold and never outside the range of 500' to 1,500'.

v. When determining the target touchdown point, consider that visual and Electronic glide slopes may intersect the runway surface beyond the 1000' point and some runways may have a displaced threshold

vi. A shallower approach path of less than 3° and a down slope on the runway make an accurate touchdown progressively more difficult.

vii. If for any reason the approach path is not maintained and it is likely that the touchdown will occur too short or too far beyond the touchdown area, or the threshold speed is excessive then a go-around must be initiated.

viii. The computed landing crosswind component should be determined using the steady wind velocity and based on this component, the cross-wind limit must not be exceeded.

*As per Boeing 737 FCTM/QRH the maximum allowable airspeed during approach is Vref + 15 kts.

1.17.3.2 Approach Briefing

The following items should be considered for mention depending on the circumstances. The statement 'Standard Calls and Procedures' will apply only when both pilots are familiar with the procedures for the airfield concerned and when further elaboration is not required.

i. Time and position for commencement of descent;

ii. Anti-icing requirements;

iii. Terrain clearance (safety altitudes);

iv. Routing, altitude and speed restrictions;

v. Use of Automation;

vi. Runway in use, type of approach, radio aid selection;

vii. CAT II / CAT IIIA Landing approach and landing, if planned.

viii. Monsoon conditions

ix. Horizontal and vertical approach pattern, including standard calls;

x. Decision height, including standard calls;

xi. Missed approach procedure (ATC and aircraft);

xii. Approach lighting, runway lights and visual aids available;

xiii. Runway surface condition and cross wind;

xiv. Taxi path after landing; and

xv. Airfield restrictions, obstructions and abnormalities.

xvi. The specific actions and phraseology (standard callouts) associated with:

- Normal go-around
- Wind shear go-around
- Approach to stall and recovery

xvii. Reminder that 360 degree turns in the Final Approach phase are prohibited

xviii. Reminder that a missed approach must be executed whenever the aircraft is not stabilized on Approach

xix. Reminder that the PM is responsible to clearly and loudly call 'GO-AROUND' when in his judgment it would be unsafe to continue with the Approach.

1.17.3.3 Stabilized Approach Procedure

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Stabilized Approach

(a) The following Stabilization thresholds need to be met**: -**

i. NPA/PAR - FAF

ii. ILS - 1000 ft AGL

iii. Visual - 500 ft AGL

(b) By this threshold, the airplane should meet the 'Stabilised Approach criteria'.

(c) During the approach, the FCU altitude 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

Stabilized Approach Criteria

(a) All appropriate briefings and checklists should be accomplished before 1000' Height Above Threshold (HAT) in instrument meteorological conditions (IMC), and before 500' HAT in visual meteorological conditions (VMC).

(b) An approach is considered stabilized 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 Vapp + 10 knots IAS and not lower than Vapp - 5 knots trending to Vapp.

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 stabilized if they also fulfil the following**:-**

i. ILS Cat-1 approaches are flown within 1 dot of G/ S and localizer.

ii. ILS Cat-2 approaches: The airplane must be flown within the expanded localizer scale.

iii. Visual Approach: the Wings must be level on final approach when the airplane reaches 500 feet HAT.

iv. 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 maneuvering.

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

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^{o}
d. Pitch Attitude Lower than -2.5^{o} or higher than $+10^{o}$
e. Localiser 1 dot deviation
f. Glide slope 1 dot deviation
g. Course Greater than **Y2** dot or 2.5^{o} (VOR) or 5^{o}(ADF)
h. Thrust Any significant deviation from average thrust setting

Note:

i. It is responsibility of the PM to call out any significant deviation.
ii. 360^{o} turns on the Final Approach is prohibited and a missed approach must be executed whenever the airplane is not stabilized during this phase.
iii. It requires a great deal of self-discipline for the PM to remain 'heads down' at DA (H) and below.

Mandatory "Go-Around"

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' AGL during an instrument approach, 500' AGL during a visual 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.

1.17.4 Duties & Responsibility of Pilot-In-Command & Co-Pilot

Some of the salient Duties & Responsibilities of the Pilot-In-Command and Co-pilot as mentioned in the organization's Operations Manual are mentioned below: -

Pilot – In – Command

a. PIC is solely responsible for all decisions, functions, duties or tasks regarding Operational control i.e., initiation, continuation, diversion or termination of each flight, ensuring the highest level of safety in operations.
b. Flight preparation and execution in compliance with government and company regulations.
c. The operation and safety of the aircraft and for the safety of all persons on board when the aircraft doors are closed.
d. In the absence of company ground personnel, the PIC during his period of command is also responsible for the safety of the aircraft, crew and their comfort while on the ground.
e. To report any hazardous flight condition to the appropriate ATC facility without delay.

Co-pilot

a. Is subordinate to the PIC during the flight duty and flight execution.
b. Is equally responsible for the safety of flight operations.
c. Is expected to report facts which may influence the quality of the flight execution to the PIC.
d. Should have no doubts about his condition and proficiency before starting and during flight execution.
e. The Co-pilot is equally responsible that flight operations are conducted within the limitations imposed by the state, company and aircraft manufacturer. He shall promptly bring to the notice of the PIC any deviations in orders, instructions, limitations, procedures, etc. observed by him.
f. The Co-pilot will perform all duties as described in the company manuals under the supervision of the PIC.
g. Be alert on developments that may endanger the safety of the flight. If he believes these developments exist, he shall**: -**

i. Advise the PIC.
ii. Ask the PIC to take appropriate action.

iii. If, in his opinion, strong doubts exist as to the physical or mental fitness of the PIC (incapacitation) and/or immediate action is required to prevent a highly critical situation, he shall take such action as deemed necessary (if possible, in consultation and agreement with other crew members).

iv. The action described above may lead to a tense situation.

v. All further initiatives should be aimed at the safe completion of the flight.

1.18 ADDITIONAL INFORMATION

1.18.1 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.

Based on the Boeing 737 FCOM/QRH data for a Normal Configuration Flaps 30 landing on a Dry Runway, an approximate landing distance calculation was carried out for the present case.

The runway was reported to be dry. The crew carried out flap 30 landing.

Following parameters were recorded/calculated/reported at the time of touchdown: -

- Landing Weight: 61000 Kgs (As per Flight Plan)
- Altitude (Runway Elevation): 1908.6 feet (582 m)
- Wind: 7.71 knots Tail Wind (FMC Data)
- Slope: 1^{o}
- Temperature: 42^{o} C
- Approach Speed: 143 knots (= Vref 30)
- Thrust Reversers: Both operative

Based on the above parameters and considering Max Manual Braking, the Reference Landing Distance required was calculated as 1130 meters.

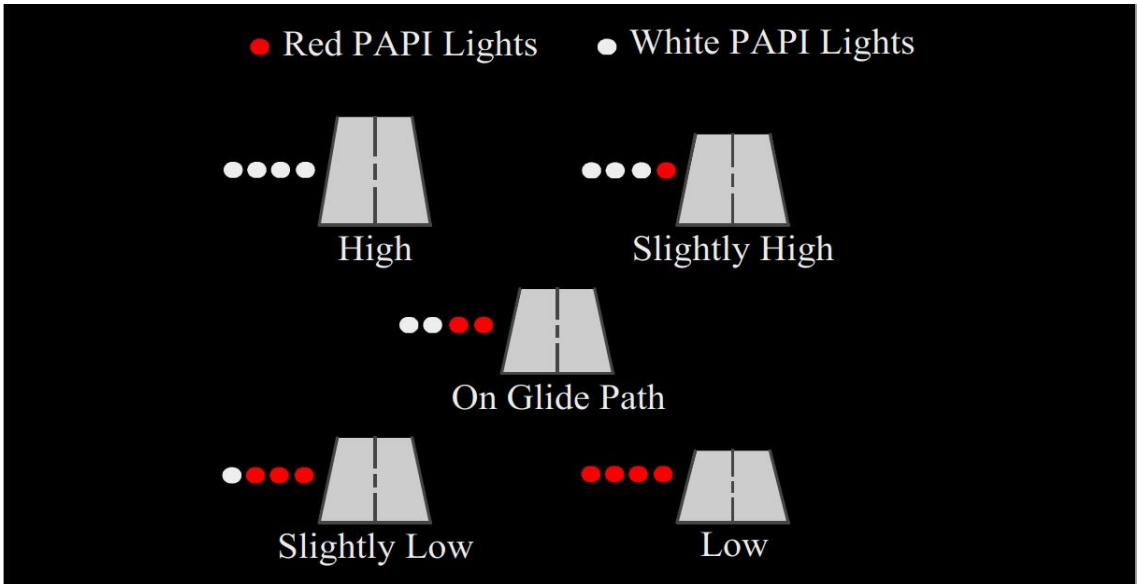
However, in this case the aircraft landed at 1445 meters ahead of runway 09 threshold, thereby only 1055 meters (2500-1445) of runway length was available for landing. Selecting Autobrakes for landing should have required more landing distance in the prevailing conditions.

The crew initially selected "Autobrakes 1" for landing, however, 04 seconds after touchdown changed over to manual braking. Manual Braking reached maximum after 13 seconds of touchdown.

1.18.2 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 18: 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 2005. 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 was valid at the time of incident. The aircraft had carried out 49005:12 Airframe hours till the day of Incident. The last

major inspection was carried out on 19th May 2018. There was no snag reported by the pilot before the incident flight.

All concerned Airworthiness Directives, mandatory Service Bulletins, and DGCA Mandatory Modifications on this aircraft and its engines were 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 this occurrence. The last snag recorded was on 24th April 2019 and the snag was "Anti-Skid INOP light in climb illuminated in cruise. Antiskid extinguished in descent". 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. Some anomalies were observed on two brake assemblies.

During inspection of the brake assembly fitted at #4 wheel i.e. on the outer wheel of right MLG, it was observed that spring guide had come out because retaining ring was missing from adjuster assembly, which holds the spring guide under spring compressed condition so that when brake is released, the piston can move back with the force of compression spring and there is running clearance in the brake to rotate the wheel freely. But in this case, piston will not move back after the brake is released and spring guide will continue to press the thrust plate and wheel will not be free to rotate and there would be a case of brake jamming/dragging.

The possible reason for retaining ring to come out would be that it was not installed properly at the time of servicing/overhaul.

In brake assembly fitted at #2 wheel i.e. on the inner wheel of left MLG, it was observed that the running clearance between one of the insulator assembly and thrust plate assembly was only 0.012 inch against the minimum permissible value of 0.050 inch. Because of less clearance, there could be a situation of brake dragging and wheel may not be free to rotate even after brakes are released.

The weak compression strength of the spring which was found cracked could result into not maintaining of the prescribed running clearance in the brake.

In view of the above, it is opined that, although the above defect/abnormalities observed during the inspection of both brake assemblies could have affected the serviceability of the braking system, but they have not contributed to the incident as the landing distance available for the aircraft to stop was not adequate.

2.2 WEATHER

The weather at the time of incident as per MET report was winds 300^{o}/07 knots with visibility 6000 meters. At the time of giving landing clearance to the aircraft for runway 09, the ATC gave wind information as 320^{o}/05 knots. As per DFDR (FMC) data, the winds at 500 feet AGL was 302^{o}/20 knots, i.e. tail wind component of 17 knots which was higher than the maximum allowable limit of 15 knots as per Organization's SOP. However, winds just before touchdown was 320^{o}/14 knots, i.e. tail wind component of 09 knots which was within the limits.

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 and auto-throttle at radio height of 1043 ft and started descending manually.
- <u>At 514 feet radio height</u>
  - The rate of descent was 1065 feet/min which was higher than the maximum permissible value of 1000 feet/minute.
  - The speed was 147 knots which was within the allowable limits.
  - N1 left was at 60% and N1 right was 58% which was high considering the aircraft is approaching for landing.
  - Winds as per FMC were 300^{o}/20 knots with tail wind component of 17 knots, which was higher than the allowable limit of 15 knots as per organisation SOP for landing.

Hence, the aircraft was not stabilized by 500 feet AGL as per the minimum requirement for landing at VMC conditions.

- From 514 feet till 165 feet radio height (aircraft height over threshold)
  - The average rate of descent was 1015 feet/min which was still higher than the maximum permissible value of 1000 feet/min.
  - The average approach speed was 151 knots, which was still within the allowable limits.
  - N1 left and right was decreased from 60% to 48% and 58% to 47% respectively.
  - The aircraft took 20 seconds to descent from 514 feet to 165 feet.

  Hence, the aircraft was not stabilized after minimums.
- The aircraft was at a height of 165 feet while overflying runway threshold.
  - The rate of descent was 1020 feet/min which was higher than the maximum permissible value of 1000 feet/minute.
  - The approach speed was 152.8 knots which was within the allowable limits.
  - N1 left was at 48% and N1 right was 46% which was still high considering the aircraft was already over runway.
  - Winds as per FMC were 300^{o}/13 knots with tail wind component of 11 knots, which was within the maximum allowable limit of 15 knots as per organization's SOP for landing.
  - The pitch attitude was 0.5^{o} Down.
- From 165 feet till touchdown
  - The average rate of descent was 602 feet/min which was within limits.
  - The average approach speed was 150 knots, with 143 knots at touchdown, which was within the allowable limits.
  - N1 left and right was increased upto 64% and 62% respectively till the height of 50 feet before decreasing it to idle power (34%) at 2 feet above ground which implies that the engine power was higher than required to "flare out" the aircraft before making touchdown.
  - The aircraft pitch attitude during this phase was Nose UP with average value of 1.8^{o}. There was sudden increase in pitch angle from 1.2^{o} to 2.1^{o} at the height of 17 feet AGL which implies initiation of flare.
  - Thereafter, the aircraft flared for about 09 seconds before touchdown which implies extended flare.

- The aircraft took 19 seconds to touch down after overflying runway threshold at a height of 165 feet.
- The aircraft landed at 4740 feet after runway threshold i.e. it landed outside the range of the prescribed touchdown area.

- From touchdown till the aircraft came to its final halt.
  - Thrust reversers and speed brakes were deployed immediately after touchdown and were functioning normally.
  - Autobrakes (1) was selected for landing, however, it was changed over to manual braking after 04 seconds of touchdown.
  - The aircraft rolled for a distance of 3990 feet and 29 seconds after touchdown till it came to its final rest.
  - The commanded brake pressure was increased to 3200 psi (LMW) & 3100 psi (RMW) in 13 seconds after touchdown, i.e. max manual braking was applied after 13 seconds of touchdown. It further implies that the brakes were functioning normally. After 17 seconds of touchdown, the commanded brake pressure of RMW decreased significantly which is consistent with manual pilot directional braking input resulting in a heading change to the left.
  - The aircraft heading started changing after 22 seconds of touchdown and was at 57^{o} when it came to its final rest i.e. heading to the left of runway heading. This is consistent with the differential friction force which will be created between Left MLG and Right MLG due to sudden decrease in right brake pressure thereby allowing right wheel to move faster than the left one.
- After 08 seconds of aircraft coming to its final halt, the N1 was again increased to 59% for left & 51% for right and subsequently after 40 seconds the N1 was again increased to 74% for left and 73% for right. This is consistent with the fact that the PIC tried to back track the aircraft by increasing power after aircraft had come to its final halt.
- The left engine was shut down 07 minutes 32 seconds after aircraft came to its final halt.

2.3.2 CVR

- After coming in contact with Shirdi Tower, co-pilot asks ATC about their sequence for landing for which the Tower informs “number three in sequence”.

- Co-pilot was heard discussing with PIC that they are very high on approach due to which PIC requests ATC for an orbit at 10 miles and while carrying out the orbit informs ATC that they will be able to land on runway 09.

- ATC then informs winds as 290^{o}/04 knots and confirms if runway 09 is acceptable to them. The PIC affirms the same and requested tower for long finals.

- The crew carried out approach briefing but did not carry out "Go-Around Procedures" as per the laid down procedures.

- The tower informs crew that the aircraft is in sight and gives the landing clearance for runway 09 and informs winds as 320^{o}/05 knots.

- Crew carried out landing checklists.

- At 500 feet (Minimums), co-pilot calls out "500, tail wind 16 knots…" and simultaneously calls out "Little high Sir" but did not call out for "Go-Around". This is consistent with the DFDR data that the aircraft was not stabilized at 500 feet.

- "No call out" was made by Co-pilot after that till touchdown. However, immediately after touchdown, the co-pilot called out "confirm sir, manual braking…..reversers…speed brakes up".

- 28 seconds after landing (thud) sound was heard, the aircraft came to its final halt with a continuous BEEP sound heard in the cockpit with co-pilot calling out "out of the runway". This is consistent with the DFDR data that the aircraft rolled for 29 seconds after touchdown before coming to its final halt.

- Immediately after aircraft came to final halt, the ATC asked crew if all operations are normal for which the co-pilot immediately responded that all operations normal as conveyed by the PIC. The PIC or co-pilot did not confirm with cabin crew if the cabin is safe and secure before calling out "All operations normal" to ATC.

- The tower then instructed crew to backtrack and vacate runway. Immediately, the sound of increase in engine power was heard in the cockpit, which is consistent with the DFDR data as 08 seconds after aircraft came to its final halt, the N1 was observed to have increased to 59%.

- The PIC asks Co-pilot to convey to tower that they are unable to back track. Accordingly, co-pilot informs the same to tower for which tower asks them to “hold at present position”. The tower again confirms if all operations are normal for which the co-pilot informs “all operations normal” as conveyed by PIC.

- ATC informed crew that “operations jeep” is approaching the aircraft and instructs them to exercise caution.

- The tower asks crew to confirm the position of the aircraft only then they informed ATC that they have crossed the runway and are on the gravel.

- The PIC asked cabin crew to hold the present position. Again, the sound of increase in engine power was heard along with continuous BEEP sound in the cockpit. This is again consistent with its DRDR data that after 40 seconds of aircraft coming to its final rest, the N1 was increased to 70%.

- Thereafter, ATC asks crew to switch off the engines.

- There was no communication from PIC/Co-pilot to cabin crew about the present situation until the cabin crew calls PIC and asks if they have to wait for some more time. The PIC informs that the vehicles are on the way and the passengers will be deboarded and also informs that the aircraft is out of the runway. The cabin crew also enquired if a step ladder will come or otherwise, they need to deploy the slides for which the PIC replied that he will confirm what to do.

2.4 OPERATIONAL FACTOR

2.4.1 CREW QUALIFICATION

Both pilots were qualified to operate the flight. PIC had a total flying experience of about8170 Hrs and Co-pilot had a total experience of about 460 hrs. Their medical and all trainings were current as on date of occurrence.

The crew were paired for the first time to operate the flight. The PIC had operated to Shirdi before and the last time he operated was on 16th April 2019, so he was well familiarized with the airport.

2.4.2 CREW HANDLING OF THE AIRCRAFT AND DECISION MAKING

2.4.2.1 Pilot – In - Command

After the aircraft came in contact with Shirdi ATC, the crew enquired about their sequence for landing. They were "number three in sequence" for landing. Initially, the aircraft was planned for landing on runway 27. The aircraft was high during descent due to which PIC carried out an orbit at 10 miles from Shirdi after taking permission from Shirdi ATC. During the orbit, PIC informed ATC that they will be able to land on "runway 09". The ATC then informed crew about the winds 290^{o}/04 knots and confirmed if they will be able to land on "runway 09". The PIC agreed for runway 09 as the visibility was 6000 meters and the winds reported by ATC were within the operating limits of organization's SOP. As the aircraft was still high, the PIC asked for long finals for approach and land on runway 09. The crew did not carry out approach briefing for runway 09, and also the "Go-Around procedures" were not discussed.

The crew aligned for long finals runway 09, they reported the same to ATC. The PIC disengaged autopilot and auto-throttle at 1043 feet. ATC gave landing clearance and reported winds as 320^{o}/05 knots. At 1000 feet, the aircraft was high, the PIC observed 3 whites and 01 red on PAPI i.e. the aircraft was not stabilized at 1000 feet AGL. The rate of descent at that time was 915 feet/minute. The crew tried to correct the same by increasing rate of descent to 1365 feet/min to achieve stabilized criteria by 500 feet AGL, which is the required minimum altitude to be achieved in case of Visual Approach. The crew carried out landing checklist before reaching 500 feet AGL.

At 500 feet AGL, the rate of descent was 1065 feet/min which was a significant deviation from the stabilized criteria. The tail wind component at that time was 17 knots as per FMC data which was slightly higher than the prescribed maximum allowable limit of 15 knots as per Organization's SOP. The speed was 147 knots which was within the prescribed limits. At this time, the co-pilot also gave a call out "Little High Sir" which also confirms that the aircraft was not stabilized by 500 feet. However, the PIC continued the approach without initiating "Go around" thereby not adhering to the laid down procedures. The aircraft was not meeting the stabilized criteria below 500 feet also, as the average rate of descent was still above 1000 feet/min. The PIC still decided to continue the approach.

The PIC had stated that, he had never carried out "go around" during his entire flying career till date of incident, except for one instance which was ATC induced. There may be a possibility that, as he had never carried out a go around earlier, he was not assured to initiate go-around or he had the confidence that he will be able to land even in adverse condition which he may have successfully carried out earlier.

The aircraft was at a height of 165 feet while overflying runway 09 threshold. To arrest the rate of descent, PIC kept the aircraft at nose up attitude throughout the descent from 144 feet AGL onwards. However, at 17 feet AGL, the PIC increased the pitch from 1.2^{o} to 2.1^{o} which implies that PIC initiated "flare" at this point. The aircraft took 09 seconds more before touch down at 4740 feet ahead of runway 09 threshold, which was well ahead of the touch down zone. Initially, Autobrakes (1) was selected for landing, which was again incorrect selection considering the prevailing MET conditions. However, the PIC realized that sufficient runway length is not available to stop the aircraft within runway; he disconnected autobrakes after 04 seconds of touchdown and started applying brakes manually. However, the aircraft overshot the runway and entered unpaved surface which was full of gravels. After the aircraft came to its final halt, ATC asked crew if all operations are normal for which the PIC asked co-pilot to convey that all operations are normal without actually analyzing the cockpit, cabin and the outside condition of aircraft. The ATC asked them to backtrack and vacate the runway as the runway 27 side is not visible from the ATC. The ATC controller did not observe that the aircraft had overshot the runway and the crew also did not inform the same to ATC. The PIC increased power and tried to backtrack but the aircraft did not move and asked co-pilot to inform ATC the same. The crew did not inform ATC that the aircraft had overshot the runway till ATC asked them to confirm their position. Even after ATC asked them to hold the present position and informed that the "operational jeep" is approaching them; the PIC again increased the power (N1 increased to 70%). PIC did not inform cabin crew about the prevailing situation and also did not enquire about the situation in cabin. The left engine was switched off after 07 minutes 32 seconds of aircraft came to its final rest and only after ATC directed them to do so.

This indicates lack of pilot's handling of the situation. He should have immediately informed ATC about the position of the aircraft and asked for immediate assistance and secure the aircraft as he was not aware of the outside situation of the aircraft. Instead

he kept on trying to backtrack by increasing power which was a very unsafe act as this could have led to an accident.

2.4.2.2 Co-pilot

The Co-pilot was Pilot Monitoring for the flight. During the final approach at minimums (500 feet), the co-pilot did call out for "high", however, he did not call out for "Go-around" even after observing that the aircraft was not stabilized throughout the final approach.

When the aircraft came to its final halt, he did not inform ATC that the aircraft had overshot the runway and entered the unpaved surface. He was just communicating to ATC what PIC was conveying to him. He also did not inform cabin crew about the prevailing situation and also did not enquire about the situation in cabin.

2.5 ORGANISATION ASPECT

2.5.1 Aircraft Operator

2.5.1.1 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 kept on trying to backtrack the aircraft without realizing the seriousness of the situation as the aircraft was on unpaved surface with full of gravels and with engines on power. This is a serious safety concern and could have led to an accident. Moreover, they did not inform the ATC that the aircraft overshot the runway till ATC asked them to confirm their position. Instead, they informed ATC that all operations are normal 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.

2.5.1.2 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. As the organisation is operating regular flights to the airfields like Shirdi, where the wind conditions change abruptly, the operating crew will be more assured to carry out the landings with tail winds if such training is included in the curriculum.

2.5.2 Aerodrome Operator

During the investigation, the investigation team visited the aerodrome and ATC facility and the observations made were analyzed with the circumstances of this incident. The same is discussed in the following paragraphs: -

Visual Wind Direction Indicator (Wind Sock)

As per the minimum requirement, one windsock has been installed on the runway 27 side. However, both runways i.e. 27 and 09 are being used for operations. The crew while approaching for landing on runway 09, is not be able to see the windsock installed on the other side of the runway.Thereby, they will not be able to estimate the instant wind conditions and act accordingly. The same was also blocked by the ATC building. Installation of another windsock at other end of runway, will assist the crew in getting instant wind conditions to take appropriate actions.

Digital Wind Indicator in front of controller

Display of Digital Wind Indicator kept in front of ATC controller which indicates instant wind information on display was found faulty. It was quite difficult to read the figures displayed on it. This may lead to incorrect wind information being provided to the aircraft crew by the controller. This may further affect the landing configuration of the aircraft.

MET Digital Readout

The MET digital readout had incorrect runway direction from source. The runway No. indicated in the equipment was incorrect.

Position of ATC Tower

It was observed that from the controller's position in ATC, the runway 27 side is not completely visible. Though the aircraft is visible, but the controller cannot ascertain the position of the aircraft on ground when it is on runway 27 side.The investigation team visited ATC when the incident aircraft was still lying at its final resting position on the unpaved surface i.e. 160 m away from runway 27 threshold. Though the incident aircraft was visible but its position could not be ascertained i.e. whether it was on the runway or out of it (Refer Pic 7). Further, the view was obstructed due to three Antenna pillars installed on the left of tower.

In the present case also, there was a situation when the controller saw some dust picking up when the aircraft reached the 27 side after touchdown on runway 09 and

the controller enquired from crew if all operations are normal. As there were no other arrangements available to ascertain the position of the aircraft, the controller is solely dependent on the crew to report their position. The crew did not inform ATC that the aircraft had overshot the runway and confirmed all operations normal. Thereafter, the controller asked them to backtrack and vacate runway. The crew tried to backtrack but could not do so as the aircraft was stuck in gravels. Only when the crew informed that they were unable to backtrack, the controller sent operational jeep to confirm the position and situation of the aircraft. Hence, due to non-availability of any arrangements/means to monitor the movement of the aircraft throughout, the controller is not able to analyze the seriousness of such a situation.

Emergency Response

Although the pilot did not inform the position of the aircraft and did not declare any emergency after it exited the runway, it led to considerable amount of time being lost for the aerodrome operator to respond to the situation. Also, to disembark the passengers, there was a considerable delay in providing the required services to the aircraft by the Shirdi airport. The passengers were disembarked from the aircraft after hours of delay which was non-adherence to the standard procedures laid down in Aerodrome Manual.

2.6 CIRCUMSTANCES LEADING TO THE INCIDENT

The ATC gave landing clearance to aircraft for runway 09 and informed winds as 320^{o}/05 knots. The aircraft was high on approach for landing and was not stabilized at 1000 feet AGL as the PIC observed 03 whites and 01 Red on "PAPI". In order to achieve stabilized criteria by 500 feet AGL which is the required minimum altitude to be stabilized in case of Visual Approach, the rate of descent was increased significantly. However, the aircraft did not meet the stabilizing criteria by 500 feet AGL, as the rate of descent was 1065 feet/min which was a significant deviation from the stabilized criteria. The tail wind component at that time was 17 knots as per FMC data which was slightly higher than the prescribed maximum allowable limit of 15 knots as per Organization's SOP. At this time, the co-pilot also gave a call out "Little High Sir" but was not assertive to call out "Go around". However, the PIC continued the approach. The aircraft was not meeting the stabilized criteria below 500 feet also, as the average rate of descent was still above 1000 feet/min. As the PIC had never carried out a go around earlier, this could have prompted him to continue the approach even in adverse condition for landing. The aircraft was at

165 feet AGL while overflying runway threshold. To arrest the rate of descent before touchdown, the PIC kept the aircraft at "nose UP attitude" with power setting higher than idle and initiated flare at 17 feet AGL. The aircraft took 09 seconds more before touch down at 1445 meters ahead of runway 09 threshold. The PIC may have realized that the aircraft had made a delayed touchdown, so he immediately changed over from "Auto brakes (1)" to "manual braking" after 04 seconds of touchdown. As the aircraft had consumed 1445 meters (more than half) of the runway before touchdown and only 1055 meters of runway length was available which was not sufficient to stop the aircraft. This resulted in aircraft overshooting the runway and entering the unpaved surface before coming to its final halt on gravels.

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 enroute flight from Delhi was uneventful.
4. Initially, the aircraft was planned for landing on runway 27 and was number three in sequence.
5. The aircraft was high on approach due which the crew carried out an orbit at 10 miles from Shirdi. The crew also informed ATC that they will be able to land on runway 09.
6. The ATC informed the winds as 290^{o}/04 knots and asked crew if runway 09 is acceptable for landing. The same was confirmed by the crew.
7. Crew carried out "landing checklist", however, "Go Around" procedures were not discussed during approach briefing.
8. The aircraft was high at 1000 feet AGL. The pilot observed 03 whites and one red on "PAPI".
9. Once the aircraft was in sight, the ATC gave landing clearance for runway 09 and reported winds as 320^{o}/05 knots.
10. The aircraft was not stabilized at 500 feet AGL and below. The rate of descent of the aircraft was higher than permissible limit of 1000 feet/min during the final approach.

11. Co-pilot called out that they were high at 500 feet but was not assertive to call for a “go around”.
12. The aircraft was at 165 feet AGL while overflying runway 09 threshold which was higher than the prescribed limit of 50 feet.
13. As per DFDR (FMC), the winds were 302^{o}/20 knots (Tail Wind component of 17 knots) at 500 feet and 298^{o}/13 knots (Tail Wind component of 11 knots) at 165 feet radio height while overflying threshold.
14. The aircraft had an extended flare and took about 09 seconds before making touchdown at 1445 meters ahead of runway 09 threshold.
15. Speed brakes and thrust reversers were deployed immediately after touchdown.
16. Initially “auto brakes 1” was selected for landing. However, 04 seconds after the touchdown the PIC changed over to “manual braking”.
17. The commanded brake pressure was observed to have increased to maximum value of 3200 psi in 13 seconds after the touchdown, i.e. max manual braking was applied after 13 seconds of touchdown. However, sudden decrease in commanded brake pressure of Right Main Wheel was observed after 17 seconds of touchdown and it continued decreasing thereafter which was consistent with manual pilot differential braking.
18. With “max manual braking” and the prevailing conditions, at the time of touchdown the required landing distance was 1130 meters. However, only 1055 meters of runway was available for aircraft to stop.
19. The aircraft did not stop within runway and entered unpaved surface before coming to its final halt (on the gravels) at 160 meters from runway 27 with heading 57^{o}.
20. On being enquired by ATC immediately after aircraft coming to its final halt, the crew informed ATC that all operations are normal without actually analyzing the situation inside and outside the aircraft.
21. The crew did not report to ATC that the aircraft had exited the runway till the ATC asked them to confirm their position.
22. Even after ATC advised crew to hold at present position and informed them that “operations jeep” is approaching them, the PIC tried to back track the aircraft by increasing power.
23. The crew switched off the engines only after the ATC directed them to do so.

3.1.2 Aerodrome Operator

1. Visual Wind Direction Indicator was blocked by the ATC building structure.
2. Digital Wind Indicator in front of controller was not clear.
3. Scientific assistance (MET) digital readout had incorrect runway direction from source.
4. Both runways 09 & 27 were used for operations, but the digital current weather indicator system was located on the 27 side and the only windsock was also located on the same side.
5. The runway 27 side is not visible from the ATC tower, i.e. the aircraft is visible, but the controller cannot observe/monitor the position of the aircraft on ground when it is on runway 27 side. Also, due to non-availability of any other arrangement to monitor the position of the aircraft, the controller is not able to analyze the seriousness of such a situation.
6. There was considerable difference between the wind information reported by the ATC and wind observed in DFDR (FMC) data.
7. There was a considerable delay in providing the emergency services to the aircraft, which is non-adherence to the standard procedures.

3.1.3 Aircraft Operator

1. There is no specific procedure in place for abnormal situations such as runway excursion/overshoot etc. which crew members will follow to ensure overall safety of the aircraft without delay.
2. Tailwind landing training was not part of initial & recurrent training program.
3. Defect/abnormalities were observed in #2 & #4 brake assemblies during the inspection which could have affected the serviceability of the braking system, but they have not contributed to the incident.

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 subsequent exiting of the aircraft from the runway.

Contributory Factors

- Non-assertive Pilot Monitoring.
- 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 follow in abnormal situations like runway excursion/overshoot etc. 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.

4.1.3 It is recommended that DGCA may advise the Aerodrome Operator to make arrangements in such a manner that the controller is able to monitor the complete operational area of the aerodrome, especially both ends of the runway.

4.1.4 It is recommended that DGCA may carry out audit/inspection of the aerodrome including the aerodrome operator giving more emphasis on Emergency services in place/Aerodrome Operations/Facilities in place including MET for safe conduct of aircraft operations.

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.

4.3 Aerodrome Operator

4.3.1 It is recommended that Operator may install another windsock on the other side of the runway.

4.3.2 It is recommended that Operator may periodically check the serviceability of the instruments available to the controller in ATC tower and develop a procedure for immediate replacement of unserviceable instruments in ATC.

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Amit Kumar

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Investigator

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Place: New Delhi