



सत्यमेव जयते

**INVESTIGATION REPORT ON INCIDENT TO
M/s INTERGLOBE AVIATION LTD. ATR 72-212A
AIRCRAFT, VT-IRA AT JODHPUR ON 30.12.2022**

**GOVERNMENT OF INDIA
DIRECTORATE GENERAL OF CIVIL AVIATION**

FOREWORD

In accordance with Annex 13 to the International Civil Aviation Organisation Convention and the Aircraft (Investigation of Accidents & Incidents) Rules 2017, the sole objective of this investigation is to prevent aviation incidents and accidents in the future. It is not the purpose of the investigation 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 report has been prepared based upon the evidences collected during the investigation and opinions obtained from the experts. Consequently, the use of this report for any purpose other than for the prevention of future incidents /accidents, could lead to erroneous interpretations.

List of abbreviations used in the report

1.	ATPL	Airline Transport Pilot License
2.	AME	Aircraft Maintenance Engineer
3.	ARC	Airworthiness Review Certificate
4.	ATPL	Airline Transport Pilot License
5.	ATS	Air Traffic Service
6.	CAMO	Continuing Airworthiness Management Organisation
7.	CM2	First Officer, in the right hand seat
8.	CSN	Cycles Since New
9.	CVR	Cockpit Voice Recorder
10.	CRM	Crew Resource Management
11.	EFB	Electronic Flight Bag
12.	DGCA	Directorate General of Civil Aviation
13.	FDTL	Flight Duty Time Limitation
14.	FCOM	Flight Crew Operations Manual
15.	FDR	Flight Data Recorder
16.	FRTOL	Flight Radio Telephone Operator's Licence
17.	FCTM	Flight Crew Training Manual
18.	FDM	Flight Data Monitoring
19.	FI	Flight Idle
20.	IAS	Indicated Air Speed
21.	IFR	Instrument Flight Rules
22.	IR	Instrument Rating
23.	PIC	Pilot In-Command

24.	PF	Pilot Flying
25.	PL	Power Lever
26.	PM	Pilot Monitoring
27.	RWY	Runway
28.	STOL	Supervised Take-off and Landing
29.	TSN	Time Since New
30.	UPRT	Upset Prevention and Recovery Training
31.	UTC	Coordinated Universal Time
32.	V_{app}	Final Approach speed
33.	V_{GA}	Go-Around Speed
34.	VFR	Visual Flight Rules

INDEX:

Contents		Page No
Synopsis		02
1	Factual information	03
1.1	History of the Flight	03
1.2	Injuries to Persons	04
1.3	Damage to Aircraft	04
1.4	Other Damage	04
1.5	Personnel Information	04
1.6	Aircraft Information	05
1.7	Meteorological Information	07
1.8	Aids to Navigation	07
1.9	Communication	07
1.10	Aerodrome Information	08
1.11	Flight Recorders	08
1.12	Wreckage and Impact Information	10
1.13	Medical and Pathological Information	11
1.14	Fire	11
1.15	Survival Aspects	11
1.16	Tests and Research	11
1.17	Organizational & Management Information	11
1.18	Additional Information	13
1.19	Useful or effective investigation techniques	18
2	Analysis	19

Contents		Page No
3	Conclusions	21
3.1	Findings	21
3.2	Probable Cause	22
4	Safety Recommendations	23

**Investigation Report on incident to M/s InterGlobe Aviation Ltd. ATR 72 aircraft
VT-IRA at Jodhpur on 30.12.2022**

1. Aircraft
 - Type : ATR 72-212A
 - Nationality : INDIAN
 - Registration : VT-IRA
2. Owner : M/s HIGHCLERE JET LEASING 1 DESIGNATED
ACTIVITY COMPANY
3. Operator : M/s INTERGLOBE AVIATION LIMITED
4. Pilot-in-Command : ATPL Holder
 - Extent of injuries : Nil
 - Co-Pilot/First Officer : ATPL Holder
 - Extent of injuries : Nil
5. Date of incident : 30.12.2022
 - Time of incident : 09:37 UTC
6. Place of Incident : VIJO - Jodhpur Airport
7. Co-ordinates of incident site : 26.2463N; 73.0426E
8. Last point of Departure : VIDP - Indira Gandhi International Airport, Delhi
9. Intended place of Landing : VIJO - Jodhpur Airport
10. No. of passengers on board : 71
11. Type of operation : Scheduled Commercial Air Transport Operation
12. Phase of operation : Landing
13. Type of Incident : Abnormal Runway Contact (ARC)

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

Synopsis:-

M/s InterGlobe Aviation Ltd. ATR 72-212A aircraft VT-IRA was scheduled to operate flight 6E-7405 from Delhi to Jodhpur on 30.12.2022. This was the first sector of the day for the operating crew members.

The PIC was the Pilot Monitoring and the First Officer was the Pilot Flying for the sector from Delhi to Jodhpur. The flight from Delhi to Jodhpur was uneventful till final approach to Jodhpur. The aircraft bounced twice upon touchdown of the Main Landing Gears and the PIC took over the control of the aircraft following which a go-around was performed. During the process of go-around the aircraft tail bumper contacted the ground. A second approach was made to Jodhpur and landed safely at Jodhpur.

DGCA-India, vide Order No DGCA-15018(06)/1/2023-DAS dated 18.01.2023 instituted investigation of the incident under Rule 13 (1) of Aircraft (Investigation of Accidents and Incidents), Rules 2017 by an Investigator-In-Charge.

The probable cause of the incident was improper technique employed by the PIC for recovery after a bounced landing.

The issues associated with poor decision making and CRM are the contributory factors in the incident.

1. Factual Information

1.1 History of flight:

On 30.12.2022 M/s InterGlobe Aviation Ltd. ATR 72-212A aircraft VT-IRA was operating a scheduled passenger flight 6E-7405 from Delhi to Jodhpur with the PIC as the Pilot Monitoring and the First Officer as the Pilot Flying.

This was the first sector of the day for the operating crew members. There was a total of 71 passengers and 04 crew members (02 Cockpit crew and 02 Cabin crew) on-board the aircraft.

Jodhpur ATC cleared the aircraft for approach to RWY05 via overhead and the same was briefed and discussed by the crew. The weather information at Jodhpur discussed during briefing was Winds 040/ 05kt, Visibility of 6km, temperature 24° C, Dew point 06°C and QNH 1020. The performance calculation was made on the on-board EFB, calculated V_{app} speed was 108kt and V_{GA} was 120kt.

Crew mentioned that during the approach winds were light turbulent and aircraft speed was varying. The PIC advised First Officer to 'Check Speed' and the same was managed by the First Officer.

The aircraft was configured for landing as per procedure, the approach was stabilised and crew continued to land. At about 20 feet the First Officer (PF) reduced the power to FI (Flight IDLE), he reportedly felt that due to turbulent conditions the flare was misjudged and aircraft was sinking faster than anticipated.

The touchdown was perceived by the crew as harder than expected owing to late flare and aircraft bounced around 2-3 feet. Suspecting that a safe landing may not be possible, the First Officer made a call for Go-around. Since the bounce was less than 05 feet which was not significant and there was no initiation for a Go-around from First Officer (Pilot Flying), the PIC ignored the Go-around call and assisted in maintaining the pitch for second touchdown to settle down the aircraft. The aircraft touched down again and once again got airborne and this time there was a reported change of direction to the right. PIC reported that due to crosswind effect the aircraft started veering towards the right, after which a Go-around was performed.

The flight crew made another approach and later landed safely at Jodhpur. PIC made a technical log entry for suspected hard landing and the Go-around performed.

1.2 Injuries to persons:

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor/None	Nil / 02 Flight Crew + 02 Cabin Crew	Nil/ 71	

1.3 Damage to aircraft:

No damage to aircraft. Rub mark was observed on tail skid shoe not extending up to wear indicator. No wear mark observed on indicator angles. Tail skid shoe paint touch-up carried out as per ATR standard practices.

1.4 Other damages:

No information has been received from Jodhpur airport in this regard.

1.5 Personnel information:

The details of the licences and ratings, of the Cockpit crew who operated the incident sector are as detailed below:-

Details	PIC	First Officer
a) Type of license	ATPL	ATPL
b) Valid upto	02.12.2023	20.10.2027
c) Date of Initial issue	17.06.2011	21.10.2022
d) Class of license	Aeroplane	Aeroplane
e) Category of license	Multi engine Land	Multi engine Land
f) Age	52 years	32 years
g) Aircraft Ratings	PIC-C152,C172, ATR 42/72 and Co-Pilot A320	PIC- C172, C208 B and Co-Pilot ATR 42/72
h) Date of Endorsement as PIC	11.04.2012	N/A
i) Date of last Medical Exam	16.06.2022	25.06.2022
j) Medical Exam validity	21.06.2023	24.07.2023
k) FRTOL Valid upto	13.10.2023	16.06.2026
l) Date of Last IR check	29.09.2022	22.07.2022

Details	PIC	First Officer
m) Date of last Proficiency Check	29.09.2022	22.07.2022
n) Total flying experience	6697:45 Hrs	3916:18 Hrs
o) Experience on Type	5944:04 Hrs	1538:23 Hrs
p) Experience as PIC on Type	2585:52 Hrs	N/A
q) Last technical refresher	21.12.2022	26.04.2022
r) Total flying experience in last 180 days (prior to incident)	350:33 Hrs	352:24 Hrs
s) Total flying experience in last 30 days (prior to incident)	63:08 Hrs	62:35 Hrs
t) Total flying experience in last 07 days (prior to incident)	14:56	08:36
u) Total flying experience in last 24 hrs (prior to incident)	NIL	NIL
v) Rest before duty	37:47 Hrs	65:10 Hrs

Both the cockpit crew members had undergone the pre-flight breath analyser test for alcohol at Delhi prior to operating the flight from Delhi to Jodhpur, the result was 'negative' and they were cleared to operate the flight.

The PIC and First Officer were cleared for STOL (Supervised Take-off and Landing).

UPRT training programme (Module 3) of M/s InterGlobe Aviation Ltd. (Indigo), includes bounced landing and the same was conducted for both the PIC and First Officer on 28.09.2022 and 21.07.2022 respectively i.e., prior to the incident.

1.6 Aircraft information:

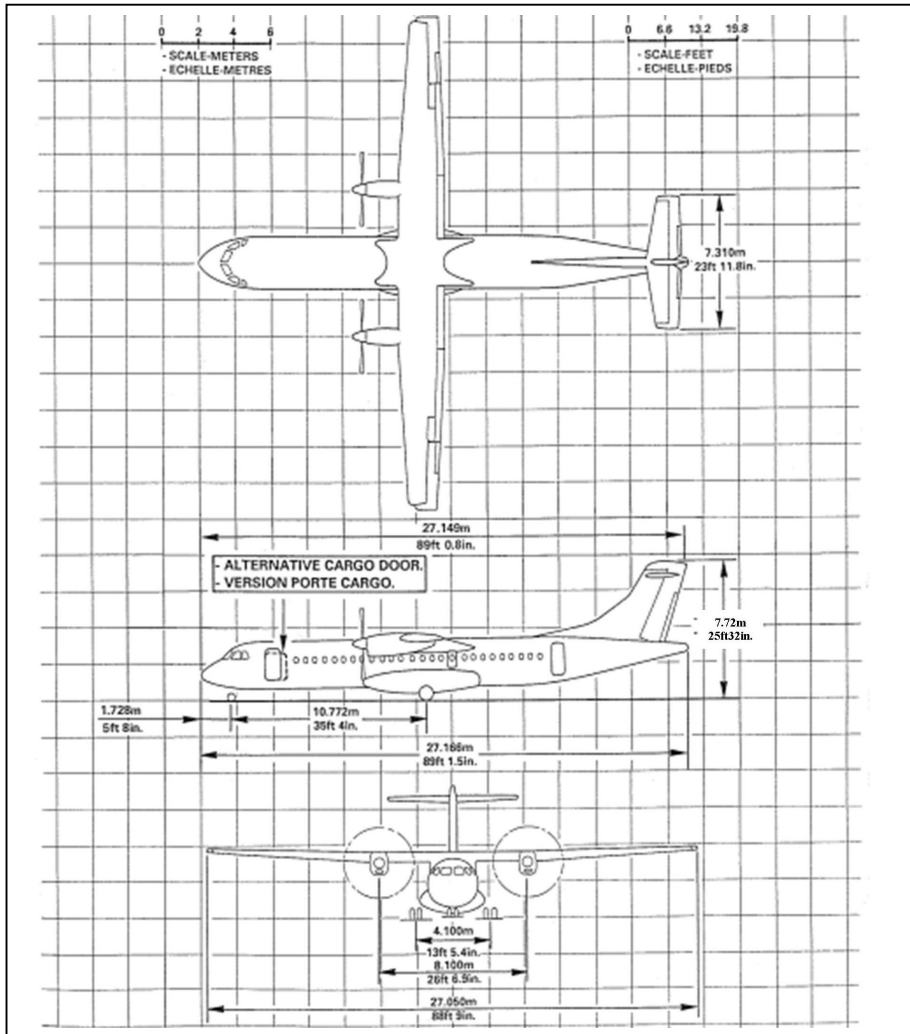
ATR 72-212A (600 Version) is a twin engine aircraft installed with Pratt and Whitney PW-127 turbo prop engine. The propeller installed on the aircraft is a six bladed HAMILTON STANDARD 568F. The aircraft is certified in Normal category, for day and night operation under VFR & IFR. Prior to the departure the aircraft weight and balance was within the operating limitations.

1.6.1 Aircraft data:-

Manufacturer	ATR-GIE AVIONS DE TRANSPORT REGIONAL
Type	ATR 72-212A
Owner	HIGHCLERE JET LEASING 1 DESIGNATED ACTIVITY COMPANY
Operator	INTERGLOBE AVIATION LTD
Manufacturer Serial no.	MSN 1623
Year of Manufacturing	2021
Certificate of Airworthiness	Issue date: 08 OCT 2021 Validity: 07 OCT 2023
Airworthiness Review Certificate	Issue Date: 01 OCT 2022 Validity: 07 OCT 2023
Category	Normal (Passenger, Mails, Goods)
Certificate of Registration and validity	5369 Validity: 16 SEP 2029
Minimum Crew Required	Two
Maximum All Up weight	23,000 Kg
Last Major inspection	05 DEC 2022 Intermediate Check Interval
Airframe Hrs since new	3545:27 Hrs
Airframe Hrs since last ARC	820:08 Hrs

1.6.2 Engine data :-

	LH	RH
a) Manufacturer	PRATT & WHITNEY CANADA	PRATT & WHITNEY CANADA
b) Type	PW 127M	PW 127M
c) Engine Serial Number	ED 2073	ED 1938
d) Type of fuel used	Jet A-1	Jet A-1
e) Time Since new (TSN)	1417:34 hrs	3545:27 hrs
f) Cycles since new (CSN)	1188	3007



General Dimensions ATR 72-212A

1.7 Meteorological information:

As per ATIS (0812UTC): Wind 040 deg 05kt, Visibility 06km, temperature 24, dew point 8, QNH1021, NOSIG. QNH was updated as 1019 by Jodhpur ATC. Surface winds reported by ATC prior to landing was 010 06kt.

1.8 Aids of navigation:

All aids to navigation were serviceable. No un-serviceability was reported.

1.9 Communication:

Two way radio communications was available between aircraft and ATC.

1.10 Aerodrome information:

Jodhpur is an Indian Air Force/ Military aerodrome located in Jodhpur, Rajasthan.

Runway physical characteristics:

RWY Designation	Dimensions of RWY (m)
05	2744 * 45
23	2744 * 45

1.11 Flight recorders:

1.11.1 CVR:

The aircraft was installed with a Solid State Cockpit Voice Recorder capable of recording two (02) hours of cockpit communications, same was downloaded and following salient observations are made:-

1. The operating crew contacted Jodhpur while in cruise and received information that runway in use was 05, QNH 1019 and expected approach was ILS Z approach for RWY 05 via overhead.
2. Crew carried out arrival briefing for Jodhpur based on available information including the actions in case of a go-around. The briefing also included discussion on the takeover procedure by PIC in-case required. It was also discussed that Temperature was 26 QNH 1019 and wind 050 05kt indicating a left hand wind /quarterly head winds were present.
3. Crew discussed that for the aircraft weight, speeds were following: V_{ref} : 107kt, V_{app} : 108kt V_{GA} : 120kt and Go-around torque used would be 100%.
4. Crew carried out approach checklist at relative time 01:34UTC.
5. At relative time 01:38:33 relative time landing gear was extended and at 01:38:48 Auto pilot was disconnected.
6. At 01:39:21 relative time crew reported established on ILS and ATC advised the 6E-7405 to continue approach for RWY05 and that surface winds were 010° 06kt.
7. At 01:40:35 relative time 6E-7405 was cleared to land RWY05, following which before landing checklist was also carried out. PIC informed the FO that Speed must not be less than 113/114.
8. 1000ft stabilized call was given by PIC at 01:41:02 relative time and First Officer informed 'Continue'.
9. At relative time 01:40:03 and at 01:41:36 UTC 'Speed' callouts were made by PIC. At relative time 01:40:14 "Speed Speed" call was given by PIC. On all occasions First Officer replied that correction is being performed.
10. The sound of first ground contact is heard at 01:42:13 relative time following which the First Officer announced a go-around but PIC replied negatively without clearly stating the

intention. PIC is heard enquiring with the First Officer as to what he was doing and the First officer replied that he didn't do anything.

11. The sound of one more ground contact is heard in the recording, following which a go-around was announced by the PIC. Following the go-around the actions as per procedures were carried out by the crew.
12. The First Officer informed the PIC that during the event DUAL input has likely occurred to which PIC replied that there was no dual input.

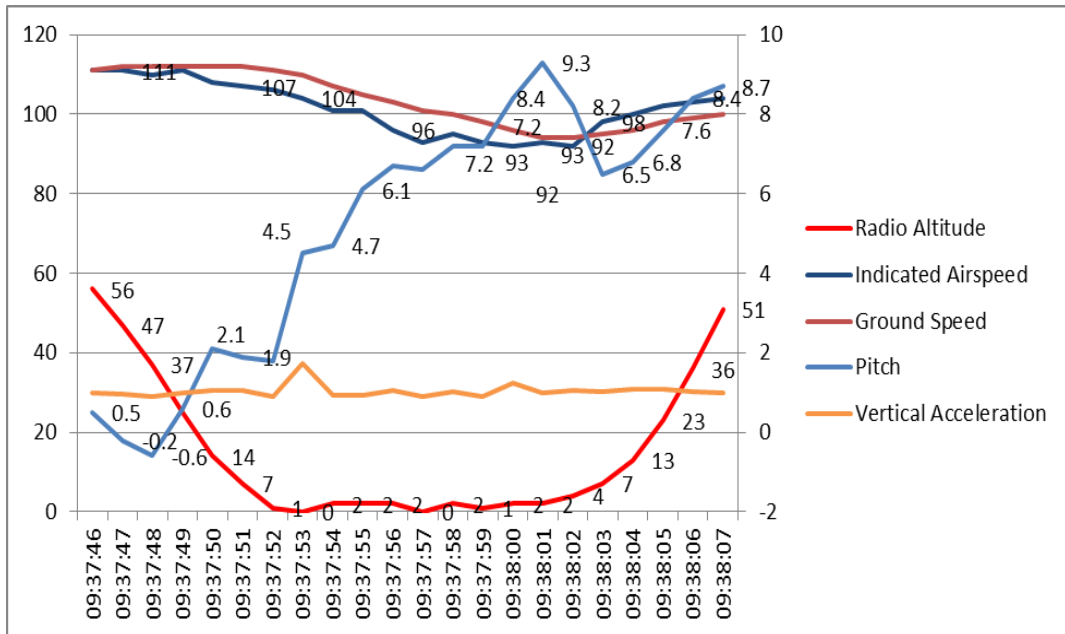
1.11.2 DFDR:

The aircraft was installed with a Solid State Flight Data Recorder. The recording of the unit was retrieved and the significant events are detailed below:-

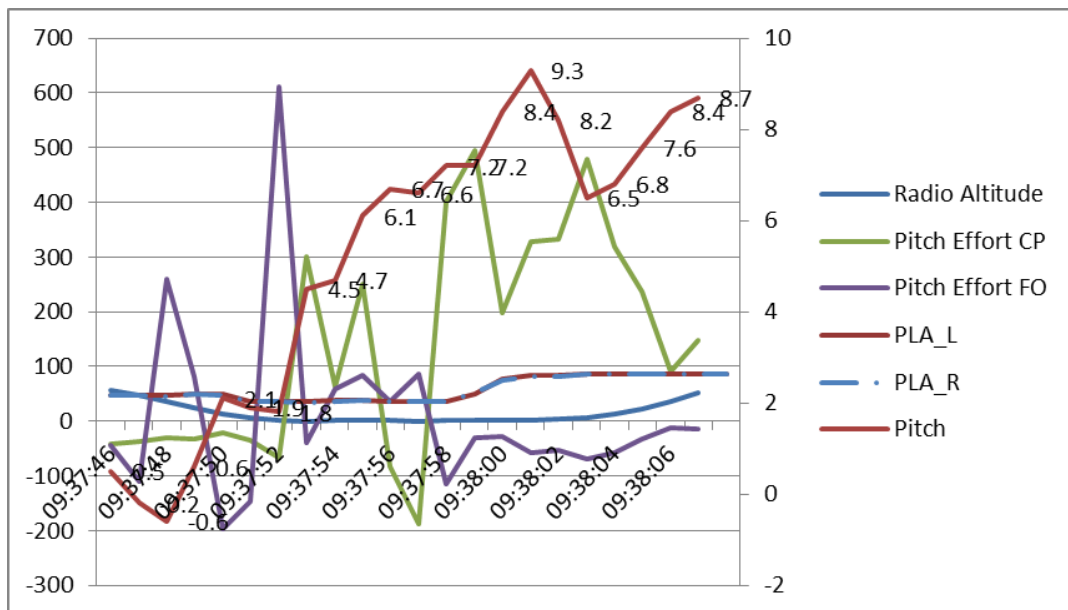
1. Auto Pilot #1 was disconnected during approach at 09:34:28UTC in approach at approx. 2600ft baro altitude.
2. Flaps 30 configuration was selected passing 2571ft baro altitude at 09:34:36 UTC.
3. Below 1000ft radio altitude till first touchdown the winds were from 350 deg and 07kt gradually shifting to 06 deg / 04 kt.
4. Passing 25ft radio altitude, the aircraft pitch was initially increased to 2.1° pitch UP
5. Below 14ft radio altitude the PL's #1 and #2 were reduced to 36° (Flight IDLE) and pitch DOWN inputs followed by significant pitch UP inputs are recorded from First Officer side. Just prior to touchdown there are recorded inputs for slight pitch DOWN from PIC side and simultaneously pitch UP inputs from First Officer side which was eased and changed to a slight pitch DOWN.
6. The first touchdown (1.8 G) occurred at 09:37:52UTC with pitch of 4.5° and vertical speed of 704 ft/min. The speed (IAS) at first touchdown was 106kt (111kt ground speed) and wind recorded is 06 deg / 04 kt.
7. At first touchdown there were DUAL inputs from PIC (for a Pitch UP) and First Officer side was also for a Pitch UP but not significant.
8. The radio altitude recorded during bounce after first touchdown is 02 feet.
9. The PIC side inputs were predominant thereon and the pitch UP commands from PIC side were eased but were still predominantly towards Pitch UP at the second touchdown. Just prior to second touchdown the aircraft pitch had reached 6.7° UP.
10. Speed at second touchdown (09:37:57UTC) had dropped to 93kt IAS, which further reduced to 92kt IAS at 09:38:00UTC.
11. The aircraft pitch steadily increased based on PIC side input reaching 7.2° at second ground contact (1.3G) and further increased reaching 8.3° at third ground contact (1.36G) at 09:37:59UTC. The First officer inputs were also recorded but after second bounce they were pitch DOWN in nature and eventually inputs from First Officer stopped.
12. Following the second ground contact, after 09:37:59 UTC the PL's were advanced forward reaching the maximum of 86° and 87° (#1 and #2 PL respectively) in about 05 seconds (09:38:03UTC). Corresponding to which IAS increased past 100kts (at 09:38:04UTC) and

increase in the vertical speed is recorded. PL#2 reached 87° in another 03 seconds. Pitch inputs from First Officer ceased after PL advancement.

- The aircraft climbed to 3500ft and landed again at 09:50:20UTC, the PITCH inputs during this second approach were from PIC side.



Time (UTC) Vs Altitude, Speed, Aircraft Pitch and Vertical acceleration (below 60ft Radio altitude)



Time (UTC) Vs Altitude, PIC and First Officer Pitch inputs, Aircraft Pitch and Power Lever (below 60ft Radio altitude)

1.12 Wreckage and impact information:

The tail skid shoe/ tail bumper contacted the runway while landing at Jodhpur. Damage was limited to paint rub on the tail skid shoe/ tail bumper. No further damage/ disintegration of any part were reported.

1.13 Medical and pathological information:

Not applicable.

1.14 Fire:

There was no fire or smoke during or following the incident.

1.15 Survival aspects:

The incident was survivable.

1.16 Tests and research:

Not applicable.

1.17 Organizational & Management Information:

1.17.1 DGCA:-

DGCA Operations circular 09 of 2017: Approach and Landing Accident Reduction (ALAR) and Control Flight into Terrain (CFIT) reduction tool kit (relevant portion is appended below):

All Operators are required to ensure that the salient points covered in ALAR Briefing Notes are incorporated in their relevant Operations Manual / Standard Operating Procedures / Training Manual. ALAR concepts must be included in Initial and Recurrent training and while conducting Proficiency Checks on aircraft and simulator.

Bouncing and Bounce Recovery

Bouncing during a landing usually is the result of one or more of the following factors:

1. Excessive sink rate;
2. Incorrect flare technique;
3. Excessive airspeed; and/or,
4. Power-on touchdown (preventing the automatic extension of ground spoilers, as applicable).

The bounce-recovery technique varies with each aircraft type and with the height reached during the bounce.

1. Recovery From a Light Bounce (Five Feet or Less)

- a) When a light bounce occurs, a typical recovery technique can be applied: Maintain or regain a normal landing pitch attitude (do not increase pitch attitude, because this could lead to a tail strike);
- b) Continue the landing;
- c) Use power as required to soften the second touchdown; and,
- d) Be aware of the increased landing distance.

2. Recovery From a High Bounce (More Than Five Feet)

When a more severe bounce occurs, do not attempt to land, because the remaining runway may be insufficient for a safe landing.

The following go-around technique can be applied:

- a) Maintain or establish a normal landing pitch attitude;
- b) Initiate a go-around by activating the go-around levers/ switches and advancing the throttle levers to the go-around thrust position;
- c) Maintain the landing flaps configuration or set a different flaps configuration, as required by the aircraft operating manual (AOM)/quick reference handbook (QRH).
- d) Be prepared for a second touchdown;
- e) Be alert to apply forward pressure on the control column and reset the pitch trim as the engines spool up (particularly with underwing-mounted engines);
- f) When safely established in the go-around and when no risk remains of touchdown (steady positive rate of climb), follow normal go-around procedures; and,
- g) Reengage automation, as desired, to reduce workload.

1.17.2 InterGlobe Aviation Ltd:

M/s InterGlobe Aviation Ltd.(IndiGo) is a scheduled airline operating a fleet of Airbus A-320, A-320 neo, A-321neo and ATR 72 aircrafts. The airline operates flights on domestic and international sectors. The aircraft's are maintained by the airline which also holds a valid Aircraft Maintenance Organisation (AMO) approval from DGCA.

1.17.2.2 Operations Manual : Approach and Landing Reduction Training

The DGCA approved Operations Manual of M/s InterGlobe Aviation Ltd.(IndiGo) refers to DGCA Operations Circular 09 of 2017. It is mentioned that ALAR concepts must be included in initial and recurrent training and while conducting Proficiency checks on aircraft and simulator.

1.17.2.2.1 Training on 'Bounce Recover'

M/s InterGlobe Aviation Ltd.(IndiGo) has reported that, Bounce Recovery/ Reject Landing were covered as part of the FDM Trends in the Recurrent Training, prior to the UPRT software upgrade in the simulators.

M/s InterGlobe Aviation Ltd.(IndiGo) has further reported that, the efficacy of the Bounced Landing and Recovery Training has been enhanced post the induction of UPRT software in the simulators in May 2022 (FSTC Hyderabad). By April 2023 all Indigo ATR pilots have completed their UPRT modules in which Bounce Landing and Recovery is included. The same was conducted for both the PIC and First Officer on 28.09.2022 and 21.07.2022 respectively i.e., prior to the incident.

1.18. Additional information:

1.18.1 FCOM Reference: Additional Normal Procedures- Flight Characteristics-Landing

In order to minimize landing distance variations the following procedure is recommended:

- Maintain standard final approach slope (3°) and final VAPP until 20 ft is called on radio altimeter
- At «20 ft» call by PM, reduce to FI and flare visually as required

During flare the airspeed decreases, resulting in a touchdown speed 5 to 10 kt lower than the stabilized approach speed.

- As soon as main landing gear is on ground
 - o Use brakes as required
 - o Control nose wheel impact
 - o Both PL: GI
 - o Both LO PITCH labels: check ON green
 - o Use reverse as required
 - o Below 70 kt, CAPT takes NWS control, F/O hold control column fully forward.

Note:

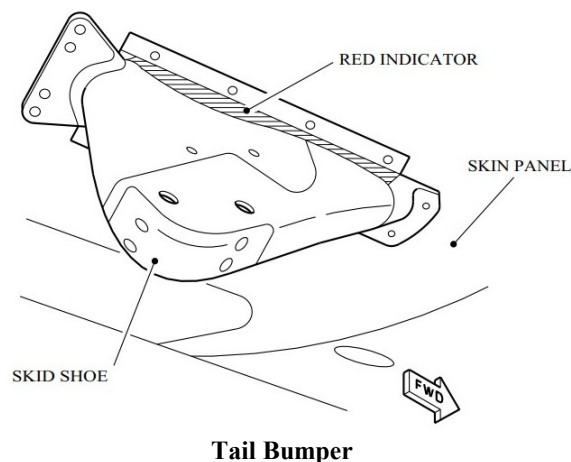
- 1) *MAX reverse is usable down to full stop if required, but to minimize flight control shaking due to reverse operation at high powers, it is helpful to release slowly PL back to GI when reaching low ground speeds (below 40 kt estimated)*
- 2) *MAX braking is usable without restriction down to full stop, whatever the runway conditions may be, provided ANTISKID is operative.*
- 3) *The tail bumper (with damping capabilities) effectively protect the tail in case of excessive attitude (resulting from prolonged/floating flares) provided the rate of sink at touchdown does not exceed 5 ft/s*
- 4) *In case of a significant bounce, a go-around should be considered*

At each walk-around, inspect skid shoe.

In case of scratches, if red indicator:

- Does not show mark of wear, aircraft can be dispatched
- Shows mark of wear, maintenance action is required.

1.18.2 FCOM Reference: Tail Bumper



1.18.3 FCOM Reference: Normal Procedures Go-Around

PF	PM
<p>Go-Around</p> <ul style="list-style-type: none"> ▶ GO-AROUND ORDER & INITIATE <i>Announce "Go-around, set power, flaps one notch".</i> • Simultaneously <ul style="list-style-type: none"> ▶ GA pb PRESS 	
<p style="text-align: center;">PF</p> <ul style="list-style-type: none"> ▶ PL 1+2..... ADVANCE TO RAMP ▶ PITCH..... ROTATE TO GA PITCH <i>Follow FD bars and accelerate to GA speed.</i> <ul style="list-style-type: none"> ▶ FMA CHECK <i>Check Go-around mode engaged.</i> <ul style="list-style-type: none"> ▶ CAVALRY CHARGE..... CANCEL <p>Positive Climb</p> <ul style="list-style-type: none"> ▶ GEAR UP..... ORDER <ul style="list-style-type: none"> ▶ FMA CHECK 	<p style="text-align: center;">PM</p> <ul style="list-style-type: none"> ▶ FLAPSRETRACT ONE NOTCH <p>CAUTION</p> <ul style="list-style-type: none"> ▶ Adjust go-around torque and avoid overtorque. ▶ PL 1+2.....CHECK <i>Check GA TQ and NP at 100 %.</i> <ul style="list-style-type: none"> ▶ FLAPS..... ANNOUNCE POSITION ▶ FMA CHECK <i>Continue with same NAV SOURCE as for approach and check Go-around mode engaged.</i> <ul style="list-style-type: none"> ▶ POSITIVE CLIMB ANNOUNCE ▶ LDG GEAR lever UP ▶ YAW DAMPERCONFIRM ENGAGED <i>Check green arrows comes on.</i> ▶ TAXI & T.O lights OFF ▶ LDG GEARS..... MONITOR <i>Check retraction sequence.</i> ▶ FGCPSET <i>Lateral setting: Check LNAV mode engaged, if not press HDG pb. Vertical setting: Press IAS pb.</i> ▶ FMA CHECK <i>When workload permit adjust NAV SOURCE and lateral mode, HDG or NAV, as required. Vertical setting : IAS.</i>
<p>Passing Acceleration Altitude</p> <ul style="list-style-type: none"> ▶ Refer to PRO.NOP.NOR.13 After Takeoff 	<ul style="list-style-type: none"> ▶ Refer to PRO.NOP.NOR.13 After Takeoff

1.18.4 FCOM Reference: Reduced Flap Landing (Tail strike pitch attitude on landing)

REDUCED FLAPS LANDING		A27.05
▶ GPWS FLAP OVRD		
<i>Avoids nuisance warnings on final approach.</i>		
▶ STEEP SLOPE APPROACH ($\geq 4.5^\circ$) : PROHIBITED		
FLAPS	LDG DIST FLAPS 30 MULTIPLY BY	APP/LDG SPD
0	2.2	V_{mHB0} + wind effect + 5 kt
15	2	V_{mHB15} + wind effect
■ If severe icing procedure applied & aircraft not clear of ice		
FLAPS	LDG DIST FLAPS 30 MULTIPLY BY	APP/LDG SPD
15	2.12	V_{mHB15} ICING + wind effect +5 kt
Note		
<i>Refer to Landing Brake Energy to determine maximum landing weight limited by braking energy for normal or delayed braking. WHEELS BRK HOT alert may be triggered and wheel fuse plug melting may occur.</i>		
<i>Refer to Landing Distance to determine LDG DIST FLAPS 30. Use for calculation LDG DIST FLAPS 30 delayed braking if landing performed with delayed braking technique. Then apply LDG DIST FLAPS 30 multiplication factor.</i>		
<i>Refer to Reduced Flaps Landing Configuration VAPP to determine APP/LDG SPD.</i>		
Note		
<i>If delayed braking technique is used, braking is performed at:</i>		
<ul style="list-style-type: none"> - 90 kt for FLAPS 15 landing - 100 kt for FLAPS 0 landing. 		
▶ ILS CAT 2 : PROHIBITED		
● During flare		
▶ PITCH ATTITUDE : DO NOT EXCEED 6°		
<i>Tail strike can occur depending on vertical speed at touchdown.</i>		

1.18.5 FCTM Reference: Bounce Landing

Bouncing at landing usually is the result of high energy approach. In-service experience shows that most of the events involving bounces at landing resulted from the following factors:

- Excessive airspeed during approach
- Engine power on touchdown
- Late flare initiation
- Incorrect flare technique

Some environmental factors could also contribute to experience bounce at landing, such as:

- Windshear and Thermal activity

Stabilized Approach:

The most efficient prevention is to ensure the approach is stabilized with a focus on the airspeed and the rate of descent.

Stabilization means:

- Aircraft configured for landing
- All briefing and checklists done
- Lateral flight path management
- Energy management
 - Pitch
 - Power
 - Speed
 - Vertical flight path

In case of un-stabilized approach, at any point during the approach, a go-around shall be performed. For indication, when the aircraft is stabilized in approach at *VAPP* on a 3° descent path, the pitch attitude should be in the range -2.5° to +1°. A pitch attitude lower than -2.5° during the approach may indicate an excess of aircraft energy.

Correct landing technique

Power reduction shall be initiated passing 20 ft. The touchdown shall occur with power levers at Flight Idle. In coordination with power reduction, the pilot flying progressively adjusts aircraft pitch to flare the aircraft.

Airspeed reduction during flare is normal. Touchdown should occur at an airspeed below *VAPP*.

Bounce Recovery - Rejected Landing

In case of significant bounce at touchdown, the following rejected landing technique must be applied:

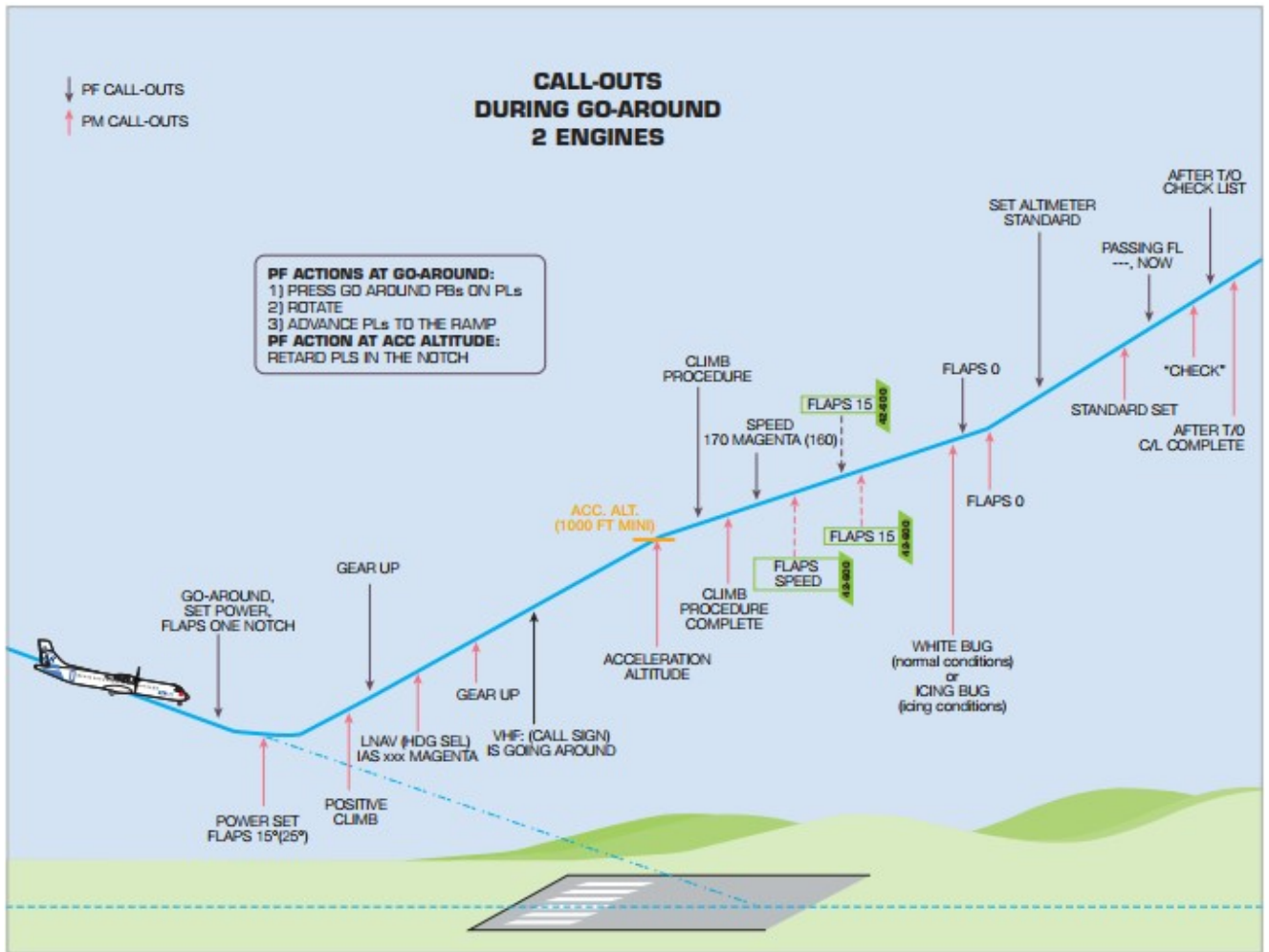
- Maintain a normal landing pitch attitude
- Initiate a rejected landing by advancing power levers to the ramp
- Maintain the landing gear and flaps configuration- Be ready for a possible second touchdown.

Should a second touchdown happen, as landing pitch attitude is maintained and power is increased, it would be soft enough to prevent damage to the aircraft.

- When steady positive climb is established, follow normal go-around procedures.

Note: When a rejected landing is initiated, the flight crew must be committed to proceed with the intended maneuver.

1.18.6 FCTM Reference: Go-around



1.18.7 Technical log:-

PIC made a technical log entry: 'Suspected hard landing by CM2 on M.W. Performed Go Around landed by Capt. Suspected Tail Skid strike during landing by CM2.'

Unscheduled inspection of Tail Bumper after rub mark observation after touchdown carried out and aircraft released to service

1.18.8 ATR Comments:-

ATR was requested for comments on the average correct PITCH attitude at touchdown with flap 30, if the flare manoeuvre is executed correctly as no specific information was available in the FCOM/FCTM.

ATR has replied that, 'Pitch angle during the flare is usually around +2/+3°. The pilots should not focus specifically on pitch values during this phase of the landing, as they should mainly focus on outside visualization and adapt it depending on the situation'.

Further information was also requested on the likely pitch attitude at touchdown with flap 30° at which tail strike can take place, if the flare is executed correctly but the pitch is raised higher than normal (Not a hard touchdown).

ATR has replied that, 'Referring to Abnormal procedure REDUCED FLAPS LANDING, Pitch attitude should not exceed 6° during flare. Above this value, a tail strike can occur due to compression of shock absorber. This value is also applicable for Flaps 30° landing since a tail strike is a geometrical relationship that depends only on aircraft attitude and height of main landing gears (not on flaps configuration). It is written in the REDUCED FLAPS LANDING procedure since it is more likely to have a higher pitch attitude during flare while performing a flaps 0° landing than flaps 30°.'

Further ATR has also added that 'This should clarify to all pilots as to what should normally be the pitch attitude at touch down and the importance of "PITCH" call by PM at 5° pitch attitude.'



Aircraft schematics- Points of contact

M/s ATR has reported the following observations after analysis of the incident flight data:

- Approach was performed in LNAV VS.
- IAS was managed well during approach.
- Approach was stabilized.
- Aircraft was properly aligned with the runway at approx 2000ft
- Nose down input at 20ft => nose down dynamic
- Then significant nose up at less than 10ft RA

Two bounces, 3 touchdowns, IAS decay during the ground phase, reaching 93kt, loss of lift with nose up input

- 1st touch 4.5° at 1.8G (no contact with point B), nose up input maintained during bounce
- 2nd touch 7.2° at 1.3G => possible contact with point B
- 3rd touch 8.3° at 1.4G IAS 93kt=> contact with point B.

1.19 Useful or effective investigation techniques:-

Nil.

2. Analysis

2.1 Serviceability of the aircraft:-

VT-IRA is an ATR 72-212A aircraft manufactured in 2021 and operated by M/s InterGlobe Aviation Ltd. The aircraft was issued a Certificate of Registration by DGCA-INDIA and its Certificate of Airworthiness and ARC were valid as on date of incident. The last major inspection performed prior to the incident was Intermediate Check Interval on 05.12.2022. The aircraft had accumulated a total of 3545:27 Hrs since new.

There were nil related defects reported prior to/ at the time of incident. The aircraft was airworthy when it was released for the flight to Jodhpur on 30.12.2022. The serviceability of the aircraft was not a factor which contributed to the incident.

2.2 Weather:-

The ATC reported winds at the time of issue of landing clearance was 10 deg 06 kt. The recorded data in FDR indicated that below 1000ft radio altitude till first touchdown the winds were from 350 deg and 07 kt gradually shifting to 06 deg and 04 kt (at first touchdown). Hence winds remained cross in nature. Weather was not a factor which contributed to the incident.

2.3 Operational handling:-

The First officer was the Pilot Flying (PF) and the PIC was the Pilot Monitoring (PM) for the sector from Delhi to Jodhpur. The subject flight was uneventful from departure till approach into Jodhpur. The Vapp for the landing was calculated by crew as 108kt. ILS Z approach to RWY05 was performed. The aircraft was fully configured before 1000ft radio altitude for the approach to runway 05 at Jodhpur. The PIC was monitoring the approach and advised the First Officer to manage the Speed during approach which was managed timely by the First Officer. The approach was stabilised and aircraft was properly aligned with RWY 05 for the landing.

Below 25ft radio altitude, the aircraft pitch was initially increased to 2.1° pitch UP and again it was reduced before rapidly increasing to 4.5° on initial touchdown. The Vapp for the landing was calculated by crew was 108kt and the speed at initial touchdown was 106kt (IAS) and 111kt (Ground speed). PL was retarded to Flight Idle below 14ft radio altitude. The aircraft bounced upon touchdown to about 02 feet radio altitude and the First Officer announced a Go-around but did not initiate the go-around actions, the Go-around call was negated by the PIC. The PIC applied inputs for pitch during first touchdown and applied pitch UP inputs whereas the First Officer inputs were also pitch UP (not significant). Though Go-around was announced by the First Officer, he did not take the actions required for a Go-around.

Just prior to second touchdown the Pitch inputs were eased by the PIC and the aircraft pitch had reached 6.7° UP. The aircraft pitch attitude continued to be increased and the aircraft 'speed' trend was reducing, the IAS had dropped to 93kt. The aircraft pitch was again increased by pitch UP inputs from the PIC side and one more peak in vertical load in recorded indicating another bounce,

at this time aircraft pitch had reached 7.2° at this point of time. PL was advanced for a Go-around (in about 03 seconds after second touchdown) during which the pitch was further increased reaching 8.3° at third ground contact (1.36G) following which aircraft climbed out.

Power reduction was initiated passing 14 ft radio altitude and the touchdown occurred with power levers at Flight Idle. However, in coordination with power reduction, the First Officer (PF) did not progressively adjust the aircraft pitch to flare the aircraft. The First Officer announced a Go-around but did not initiate it. The PIC felt that the bounce was not significant and attempted to assist in landing the aircraft. The PIC's attempt to assist the First Officer (PF) resulted in 'DUAL input' for about 07 seconds. The PIC did not announce that he has taken over the aircraft controls. Further, the PIC did not maintain the aircraft pitch after first touchdown rather he increased the aircraft pitch beyond the limitations. These actions resulted in increase of aircraft pitch well above the threshold geometric value of 6° pitch UP for a tail strike.

There was no effective monitoring of the flight parameters as no call-outs were made by either crew members regarding aircraft speed and the pitch attitude during the period of bounce upon landing till lift off. The aircraft speed had reduced to 92kt IAS at time of go-around initiation which was significantly lower than V_{APP} and V_{GA} .

It can be seen from the above that, the flare initiation was late and flare technique used by the First Officer was incorrect as it was weak flare, for which no calls were made by the PIC which resulted in a bounce upon initial touchdown. The First Officer did not initiate the Go-around actions though he announced it, indicating poor decision making.

The aircraft bounce was less than five feet and hence maintaining the normal landing pitch attitude would have been sufficient to recover from the light bounce (less than five feet) on initial touchdown. The PIC attempted to land the aircraft after the first bounce but increased the pitch attitude of the aircraft after the bounce with continuous 'nose up' input rather than maintaining a normal landing pitch attitude. The increase in pitch attitude by the PIC beyond limitations and failure of both crew members to monitor the air speed during the execution of go-around eventually resulted into a tail strike.

From the above, it can be seen that the PIC actions were not in accordance with the FCTM procedure for a Bounce recovery. The PIC identified that the bounce was not significant and attempted to assist the First Officer in settling down the aircraft. Though Go-around was announced by the First Officer, he did not initiate the actions required for a Go-around.

From correlation of CVR and DFDR data it is apparent that, the PIC was assertive in performing a landing even though the First Officer who was the Pilot Flying announced a Go-around. The PIC did not announce that he has taken over the aircraft controls and attempted to settle down the aircraft which resulted in 'DUAL input' for about 07 seconds. There was no monitoring of the flight parameters or call-outs performed by both crew members regarding aircraft speed and the pitch attitude after the first bounce and till lift-off. The change of roles PF/PM was not managed. It is evident from the above that, there was lack of effective CRM during the critical phase of flight.

2.4 Flight Crew training regarding Bounce Recovery:-

UPRT training programme (Module 3) of M/s InterGlobe Aviation Ltd. (Indigo) was started effective from May 2022, which includes 'bounced landing' and the same was conducted for both the PIC and First Officer on 28.09.2022 and 21.07.2022 respectively i.e., prior to the incident. Hence, the operating crew of the subject flight were trained for handling a bounce event during landing.

3. Conclusion

3.1 Findings:

1. The aircraft was airworthy when released from Delhi for the flight.
2. The aircraft was having a valid Certificate of Registration, Airworthiness Review Certificate and was maintained by M/s InterGlobe Aviation Ltd. in accordance with the approved Aircraft Maintenance Program.
3. The cockpit crew were having valid licences, ratings and were duly qualified for operating the aircraft.
4. Both the flight crew who operated the incident flight were subjected to Breath-analyzer test for alcohol consumption at Delhi prior to departure to Jodhpur and they were cleared after a 'Negative' test result.
5. PIC was the Pilot Monitoring and the First Officer was the Pilot Flying for the flight sector.
6. Both the PIC and First Officer had undergone requisite training and assessment for Supervised Take-off and landing.
7. The operating crew were trained for handling a 'bounce' event during landing.
8. FDTL of both the flight crew members were within the specified limits.
9. The flight from Delhi to Jodhpur was uneventful till final approach to Jodhpur.
10. The wind at Jodhpur was cross winds for runway 05, below 1000ft radio altitude till first touchdown the winds were from 350 deg and 07kt gradually shifting to 06 deg and 04 kt (at first touchdown). The Vapp for the landing was calculated by crew as 108kt.
11. The aircraft was fully configured above 1000ft radio altitude for the approach to runway 05 at Jodhpur.
12. The flight control inputs during first approach were from First Officer and below 25ft radio altitude, the aircraft pitch was initially increased to 2.1° pitch UP simultaneously PL was retarded to Flight Idle below 14ft radio altitude. The aircraft pitch was then reduced before rapidly increasing to 4.5° on initial touchdown. Speed at initial touchdown was 106kt IAS.
13. In coordination with power reduction, the pilot flying did not progressively adjust the aircraft pitch to flare the aircraft. Flare initiation was late and flare was weak.
14. No calls were made by the PIC for the late and weak flare which resulted into a bounce upon initial touchdown.
15. The aircraft bounced upon touchdown to about two (02) feet radio altitude. Though Go-around was announced by the First Officer, he did not initiate the actions required for a Go-

around. Go-around call was negated by the PIC. The PIC was assertive in performing a landing even though the First Officer who was the Pilot Flying announced a Go-around.

16. The PIC applied pitch UP inputs during first touchdown, the First Officer inputs were also pitch UP (not significant input).
17. The PIC identified that the bounce was not significant and attempted to assist in settling down the aircraft.
18. The PIC's attempt to assist the First Officer (PF) resulted in 'DUAL input' for about 07 seconds. The PIC did not clearly announce his intentions or that he has taken over the aircraft controls.
19. Just prior to second touchdown the Pitch inputs were eased by the PIC and the aircraft pitch reached 6.7° UP. The aircraft pitch attitude continued to be increased and the aircraft 'speed' was in a reducing trend, the IAS dropped to 93kt.
20. The aircraft pitch was again being increased by pitch UP inputs by the PIC, reaching value of 7.2° degree UP and this was followed by PL advancement for go-around (in about 02 seconds after second touchdown) after the second bounce. One more peak in vertical load in recorded indicating another ground contact, at this time aircraft pitch had reached 8.3° at this point of time.
21. The aircraft speed was 93kt IAS at time of go-around initiation which was significantly lower than V_{APP} and V_{GA} .
22. The PIC did not maintain the aircraft pitch after first touchdown rather he increased the aircraft pitch beyond the limitations.
23. The action of increasing aircraft pitch prior to adding power lead to a reduction in airspeed and eventually led to an increase of aircraft pitch well above the threshold geometric value of 6° pitch UP for a tail strike.
24. The aircraft pitch was 7.2° UP during second touchdown wherein the tail skid could have made possible ground contact and 8.3° UP during third touch wherein the tail skid made ground contact.
25. The PIC did not announce that he has taken over the aircraft controls. The change of roles PF/PM was not managed.
26. There was lack of effective CRM during the critical phase of flight, as effective monitoring of the flight parameters or call-outs were not performed by either crew members regarding aircraft speed and the pitch attitude after the first bounce and till lift-off. These were issues associated with poor decision-making, ineffective communication and poor resource management.

3.2 Probable cause:-

The probable cause of the incident was improper technique employed by the PIC for recovery after a bounced landing.

The issues associated with poor decision making and CRM are the contributory factors in the incident.

4. Safety Recommendations:-

In-view of the findings DGCA HQ may take necessary action.

(LINJU VALAYIL PHILIP)
Deputy Director of Air Safety
Investigator-In-Charge

Date: 28.03.2024

Place: New Delhi