FINAL INVESTIGATION REPORT

SERIOUS INCIDENT – SERENE AIR FLIGHT ER 522 BOEING 737-800, REG. NO. AP-BNB AT JINNAH INTERNATIONAL AIRPORT KARACHI ON 02-03-2022

Dated:

SCOPE

Aircraft Accident Investigation Board (AAIB), Pakistan investigations are conducted in accordance with Annex-13 to the International Civil Aviation Organization (ICAO) Convention on International Civil Aviation and Civil Aviation Rules 1994 (CARs 94).

The sole objective of the investigation and the final report of an accident or incident under above stated regulations is the prevention of future accidents and incidents of similar nature. It is not the purpose of such an investigation to apportion blame or liability. Accordingly, it is inappropriate to use AAIB Pakistan investigation reports to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

This report contains facts which have been determined up to the time of publication. Such information is published to inform the aviation industry and the public about the general circumstances of civil aviation accidents and incidents.

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ABBREVIATIONS & CODES

Abbreviation	Description
AAIB	Aircraft Accident Investigation Board
AIIAP	Allama Iqbal International Airport
AIP	Aeronautical Information Publication
AOA	Angle of Attack
ARC	Abnormal Runway Contact
CARs	Civil Aviation Rules
CG	Center of Gravity
cm	Centimeters
DFDR	Digital Flight Data Recorder
FCOM	Flight Crew Operations Manual
FL	Flight Level
FO	First Officer
h	Hour(s)
ICAO	International Civil Aviation Organization
in	Inches
JIAP	Jinnah International Airport
M	Mach
MLG	Main Landing Gears
MMO	Maximum Mach Operating
MOR	Mandatory Occurrence Report
NLG	Nose Landing Gear
PCAA	Pakistan Civil Aviation Authority
PF	Pilot Flying
PM	Pilot Monitoring
PMD	Pakistan Meteorological Department
R/W	Runway
s	Second(s)
UTC	Universal Time Coordinated
WOW	Weight on Wheels

INTRODUCTION

The serious incident was reported by M/s Serene Air Mandatory Occurrence Report (MOR) to Aircraft Accident Investigation Board (AAIB), Pakistan. Ministry of Aviation, Government of Pakistan issued Memorandum and Corrigendum authorizing AAIB, Pakistan to investigate the serious incident. The investigation has been conducted by Aircraft Accident Investigation Board (AAIB), Pakistan. This serious incident was notified in accordance with ICAO Annex-13. All corresponding timings are mentioned in Universal Time Coordinated (UTC).

SYNOPSIS

On 2nd March, 2022, Serene Air Flight ER 522, Boeing 737-800 aircraft bearing Reg. NO. AP-BNB was a scheduled passenger flight from Jinnah International Airport (JIAP), Karachi to Allama Iqbal International Airport (AIIAP), Lahore. During take-off at JIAP, Karachi a light noise was heard during nose rotation which was suspected to be a bird hit. However, all engine indications as well as flight control response remained normal and flight was continued. The same observation was reported to maintenance crew after landing at AIIAP, Lahore. During post flight inspection, the tail skid cover was found to be scratched with no other damage to the aircraft. Based on the observation of the Flight Crew and the physical evidence, it was ascertained that a tail strike had occurred possibly during take-off.

SECTION 1 - FACTUAL INFORMATION

1.1. History of the Flight

1.1.1. Serene Air flight ER 522, Boeing 737-800 aircraft, Reg. No. AP-BNB was a scheduled passenger flight of from JIAP, Karachi to AIIAP, Lahore. The aircraft departed JIAP, Karachi at 06:21:00 hours (h) and landed at AIIAP Lahore at 07:36:00 h. During take-off, an unusual noise was heard by the Flight Crew which was suspected to be a bird hit. Take-off was continued as all aircraft and engine parameters were normal. After take-off, all engine instruments, control response and cabin pressurization remained normal because of which flight was continued. After landing, the observation was reported to the maintenance crew who, during post flight inspection, discovered that the tail skid cover had scratched the ground with green cartridge fully visible.

1.2. Injuries to Persons

1.2.1. During this occurrence there were no injuries to either crew or passengers.

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor /	Nil	Nil	Nil
None	Nil	Nil	Nil

1.3. Damage to Aircraft

1.3.1. Tail cover scratched, with green cartridge visible. There was no other damage to the aircraft observed.

Figure 1 Tail Boot Scratch Marks

1.3.2. There was no maintenance carried out and aircraft was released for flying.

1.4. **Other Damage**

1.4.1. Not Applicable.

1.5. **Personnel Information**

1.5.1. Both the Flight Crew were medically fit to undertake the flight.

Flight Crew	Aircraft Flown	Total Experience	P1	P2
Captain	F-27 A-300 / A-310 B-707 / B-737-300 / B-737-800 / B-747 / B-777	22000 h	16000 h	6000 h
First Officer	C-152 / 172 B737-800	2100 h (1360 h on B737)	NIL	2100 h

1.6. **Aircraft Information**

Aircraft Information	
Registration	AP-BNB
Aircraft make and model	Boeing 737-800
Construction Number	39050
Line Number	4196
Year Built	2012
Operator/Owner	Serene Air

1.7. **Meteorological Information**

1.7.1. No significant weather was reported at JIAP, Karachi or AIIAP, Lahore at the time of the incident.

1.8. **Aids to Navigation**

1.8.1. Navigation aids for both JIAP, Karachi as well as AIIAP, Lahore are attached. There was no abnormality reported for either airport.

1.9. Communications

1.9.1. Communication frequencies for both JIAP, Karachi as well as AIIAP, Lahore are attached respectively. There was no abnormality reported for either airport.

1.10. Aerodrome Information

1.10.1. Aerodrome information for both JIAP, Karachi as well as AIIAP, Lahore are attached respectively. There was no abnormality reported for either airport.

1.11. Flight Recorders

1.11.1. Digital Flight Data Recorder (DFDR) was analyzed to ascertain the parameters on take-off and to check for any abnormalities. Analysis of DFDR data on take-off reveals that the aircraft pitch angle just prior to Main Landing Gears (MLG) lifting off the ground was 9º while at the moment of lift off was 9.5º. Correspondingly, the rate of pitch up at the time was 4.2°/s.

1.11.2. **Over Speed Event** – DFDR analysis also showed an over speed warning for the aircraft during descent from flight level (FL) 350. During descent, as the aircraft crossed FL330, the speed of the aircraft started to increase from M 0.82 till a maximum of M 0.826 after which it started to reduce. The Maximum Mach Operating (MMO) warning triggered as speed was reducing through M 0.825. This was an isolated incident during the flight following which no further exceedances were recorded.

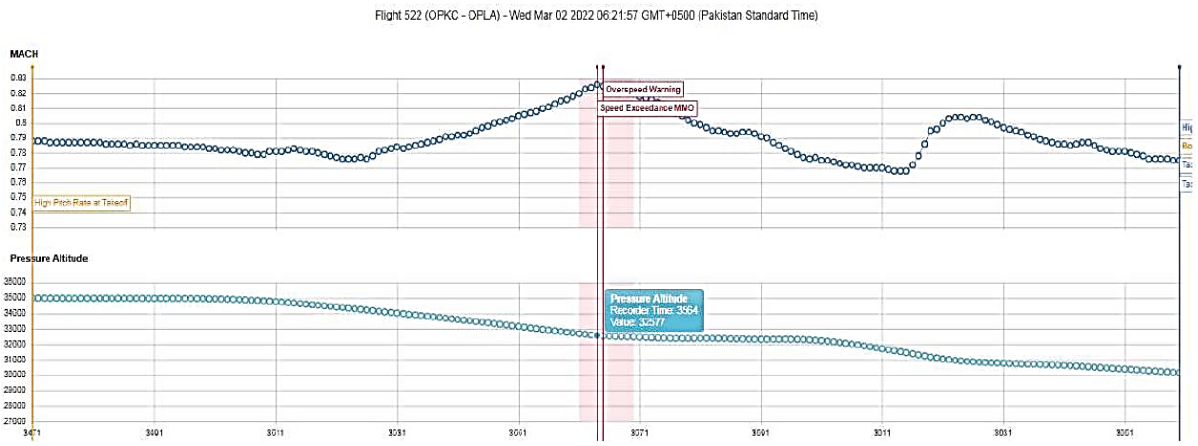


Figure 2 DFDR Data – Mach No. & Pressure Altitude

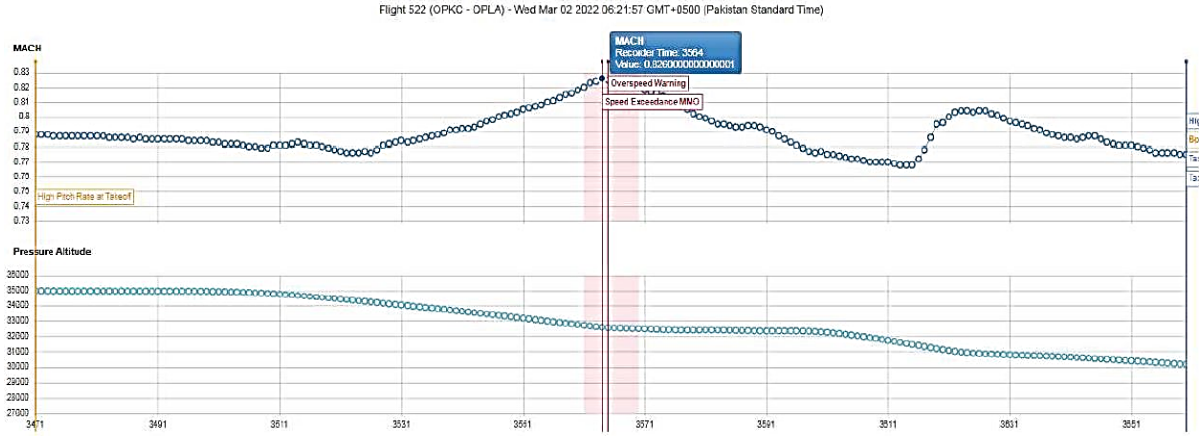


Figure 3 DFDR Data – Mach No. & Pressure Altitude

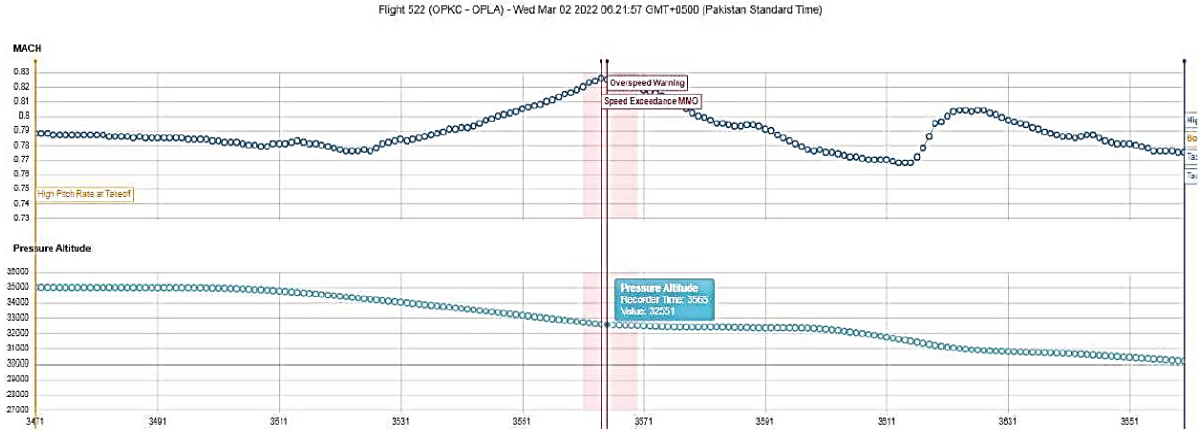


Figure 4 DFDR Data – Mach No. & Pressure Altitude

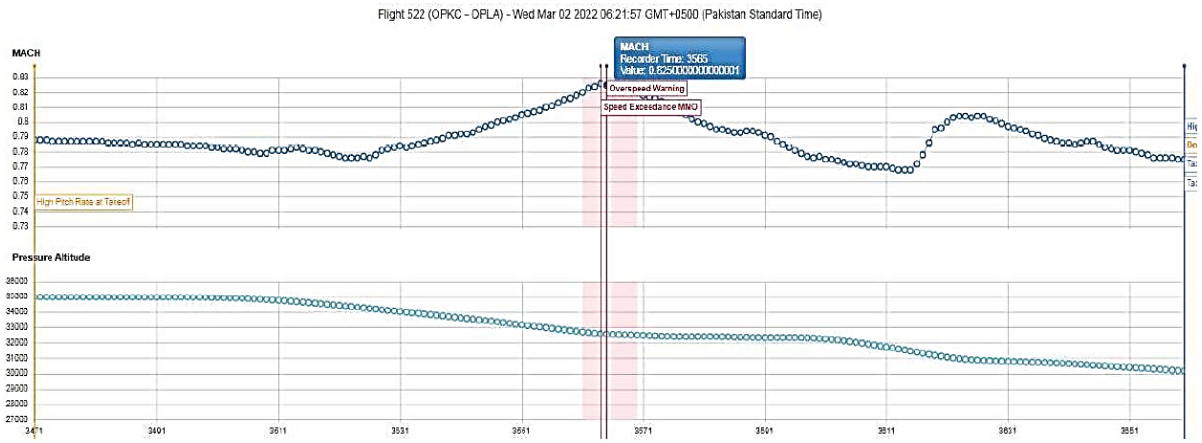


Figure 5 DFDR Data – Mach No. & Pressure Altitude

1.12. Wreckage and Impact Information

1.12.1. Not Applicable.

1.13. Medical and Pathological Information

1.13.1. Medical samples for pathological investigations were not collected after landing.

1.14. Fire

1.14.1. There was no evidence of fire in the incident.

1.15. Survival Aspects

1.15.1. Not Applicable.

1.16. Test and Research

1.16.1. Not Applicable.

1.17. Organizational and Management Information

1.17.1. Nothing significant to report.

1.18. Additional Information

1.18.1. Not Applicable.

1.19. Use of Effective Investigation Techniques

1.19.1. Standard investigation procedures and techniques were used by AAIB to investigate and ascertain the cause of the incident.

SECTION 2 – ANALYSIS

2.1. General

2.1.1. Serene Air flight ER 522, Boeing 737-800 aircraft, Reg. No. AP-BNB was a scheduled passenger flight from JIAP, Karachi to AIIAP, Lahore. Aircraft ground operations were normal and remained uneventful. For the flight, First Officer (FO) was Pilot Flying (PF) whereas the Captain was Pilot Monitoring (PM). During take-off roll at JIAP Karachi, as the aircraft nose was rotated for lift off, an unusual noise was heard by the Flight Crew which was assumed to be a bird strike. Take-off was continued as all aircraft and engine parameters were within range. After getting airborne, all engine parameters, flight control response and cabin pressurization were found to be as per normal parameters. The flight was continued for AIIAP, Lahore which remained uneventful. After landing at AIIAP, Lahore, the observation was reported to the maintenance crew. During post flight inspection, it was discovered that the tail skid cover had scratched the ground and the green cartridge was fully visible. This discovery along with the flight crew observation indicated that an Abnormal Runway Contact (ARC) in the form of tail strike had occurred probably during take-off.

2.1.2. **Aircraft Loading** – Aircraft loading was correctly carried out within the prescribed CG limits (25.2%) with an all-up weight of 68.8 tons.

2.1.3. **Crew Qualification** – Both the Captain and FO were qualified on type with adequate experience.

2.1.4. **Take-Off Rotation** – Analysis of DFDR data at the time of take-off indicates a high pitch angle as well as a high rate of pitch up upon take-off rotation.

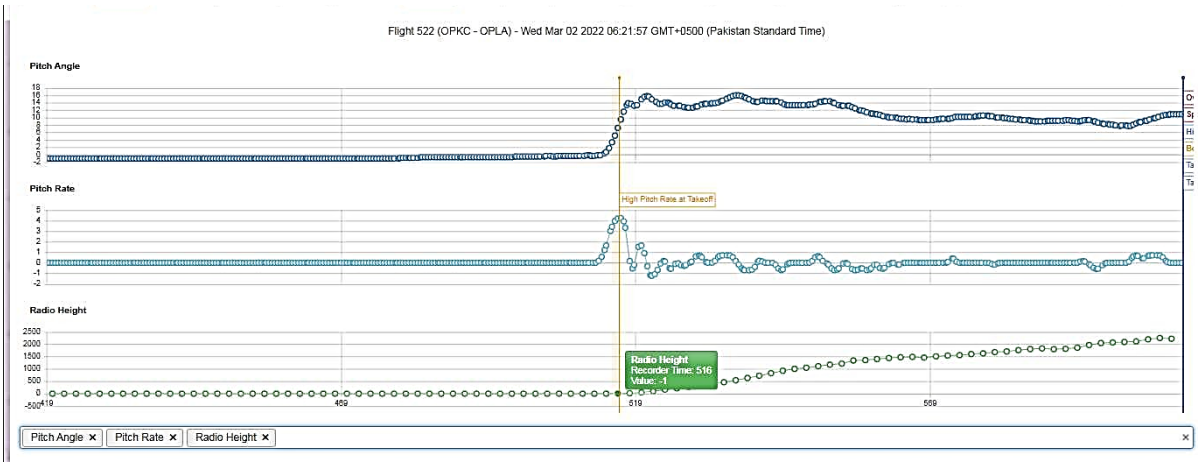


Figure 6 DFDR Data – Take-off Data: Pitch Angle, Pitch Rate & Radio Height

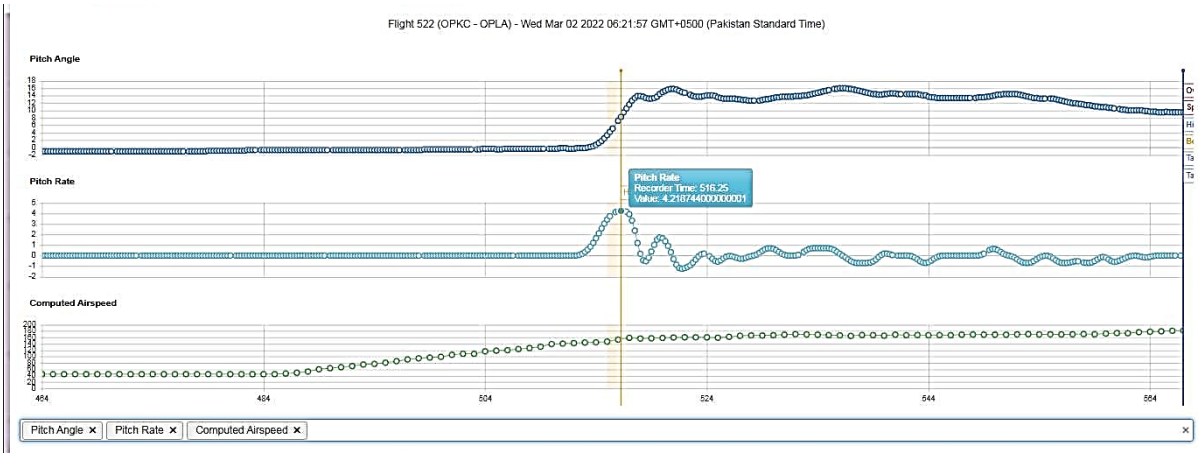


Figure 7 DFDR Data – Take-off Data: Pitch Angle, Pitch Rate & Computed Airspeed

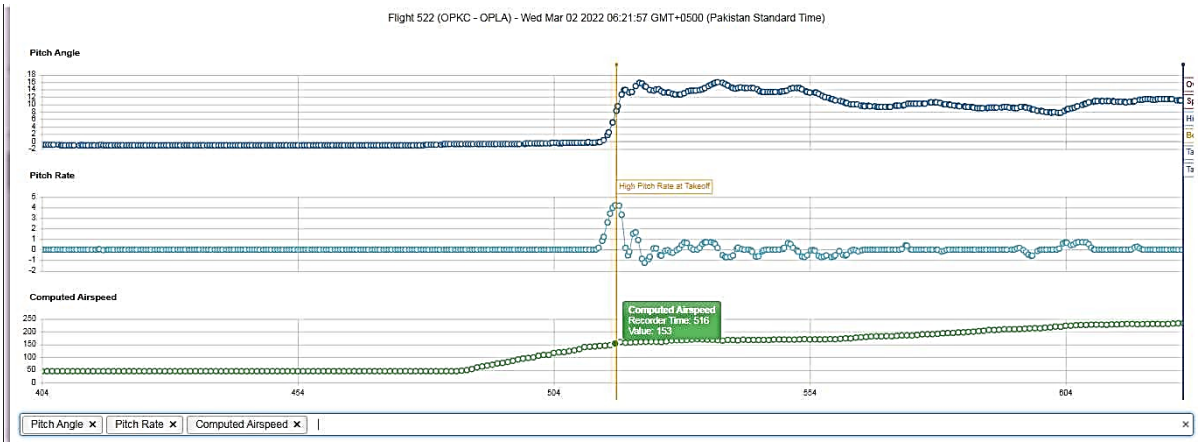


Figure 8 DFDR Data – Take-off Data: Pitch Angle, Pitch Rate & Computed Airspeed

2.1.5. As per the data recorded, the rate of pitch up increased constantly as the aircraft approached lift off speed. At the moment of lift off when Weight On Wheels (WOW) on MLG was removed, the rate of pitch peaks out at 4.2°/s which is higher than normal rate of 2-3°/s. Correspondingly, the pitch angle also increases constantly reaching a maximum of 9.5º at lift off point.

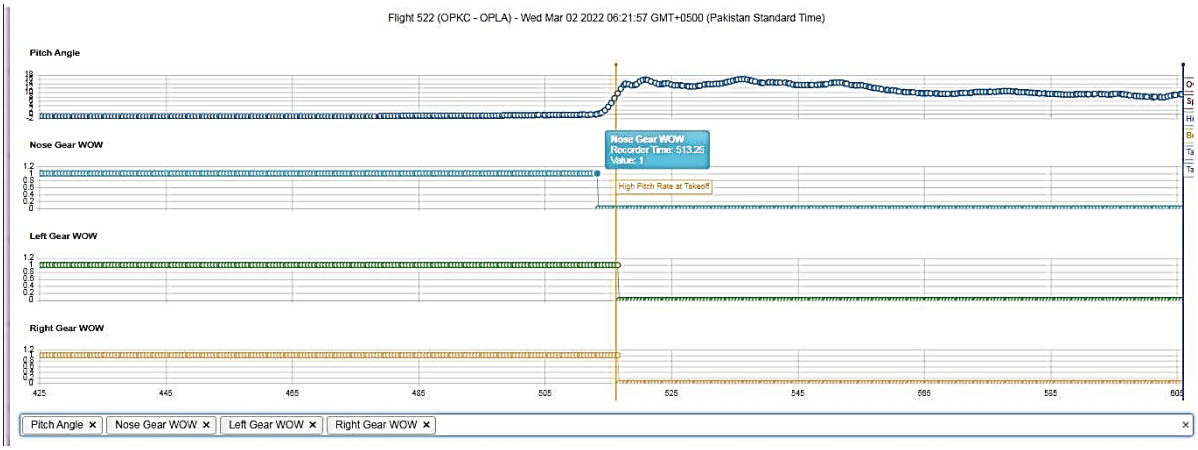


Figure 9 DFDR Data – Take-off Data: Pitch Angle, NLG WOW & MLGs WOW

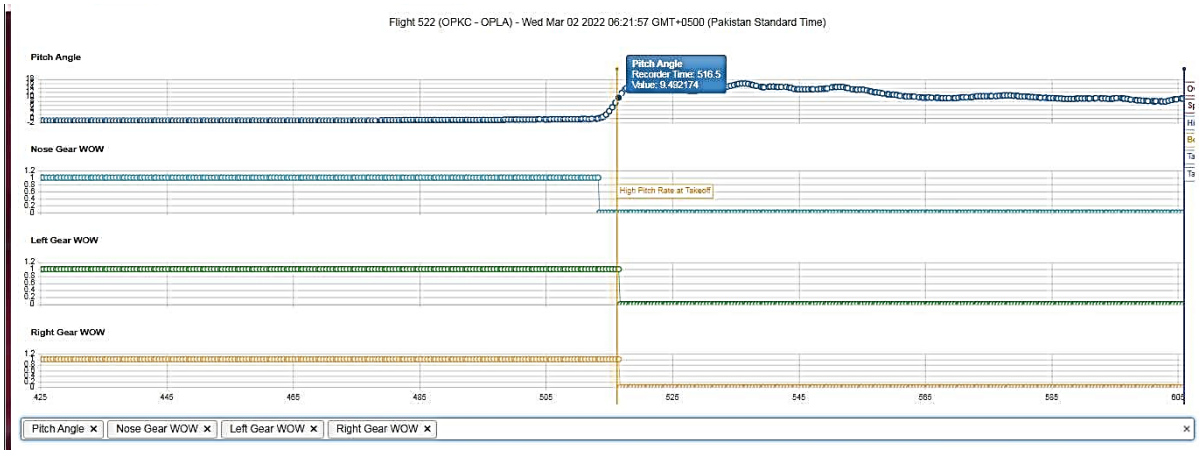


Figure 10 DFDR Data - Take-off Data: Pitch Angle, NLG WOW & MLGs WOW

2.1.6. **Boeing 737-800 Flight Crew Operations Manual (FCOM)** – As per the FCOM of Boeing 737-800, aircrew transitioning from aircraft with unpowered controls are prone to apply excessive back pressure during take-off which may result in tail skid coming into contact with the R/W surface. Additionally, a higher than normal rate of pitch up can also result in a tail strike. Moreover, the FCOM also specifies the limits for pitch up attitude to avoid tail strike during take-off.

Tail Strike

Tail strike occurs when the lower aft fuselage or tail skid (as installed) contacts the runway during takeoff or landing. A significant factor that appears to be common is the lack of flight crew experience in the model being flown.

A tail strike can be identified by the flight crew or cabin crew.

Any one of the following conditions can be an indication of a tail strike during rotation or flare:

- a noticeable bump or jolt
- a scraping noise from the tail of the airplane
- pitch rate stopping momentarily

737-800 - 737-900ER

- the TAILSTRIKE HUD warning (as installed) may be displayed

Note: Anytime fuselage contact is suspected or confirmed, accomplish the appropriate NNC without delay.

Takeoff Risk Factors

Understanding the factors that contribute to a tail strike can reduce the possibility of a tail strike occurrence.

Any one of the following takeoff risk factors may precede a tail strike:

Mistrimmed Stabilizer

This usually results from using erroneous takeoff data, e.g., the wrong weights, or an incorrect center of gravity (CG). In addition, sometimes information is entered incorrectly either in the flight management system (FMS) or set incorrectly on the stabilizer. The flight crew can prevent this type of error and correct the condition by challenging the reasonableness of the load sheet numbers. Comparing the load sheet numbers against past experience in the airplane can assist in approximating numbers that are reasonable.

Rotation at Improper Speed

This situation can result in a tail strike and is usually caused by early rotation due to some unusual situation, or rotation at too low an airspeed for the weight and/or flap setting.

Trimming during Rotation

Trimming the stabilizer during rotation may contribute to a tail strike. The pilot flying may easily lose the feel of the elevator while the trim is running which may result in an excessive rotation rate.

Figure 11 Boeing 737 FCOM

Excessive Rotation Rate

Flight crews operating an airplane model new to them, especially when transitioning from an airplane with unpowered flight controls to one with hydraulic assistance, are most vulnerable to using excessive rotation rate. The amount of control input required to achieve the proper rotation rate varies from one model to another. When transitioning to a new model, flight crews may not realize that it does not respond to pitch input in exactly the same way as their previous model.

Improper Use of the Flight Director

The flight director provides accurate pitch guidance only after the airplane is airborne. With the proper rotation rate, the airplane reaches 35 feet with the desired pitch attitude of about 15°. However, an aggressive rotation into the pitch bar at takeoff is not appropriate and can cause a tail strike.

Landing Risk Factors

A tail strike on landing tends to cause more serious damage than the same event during takeoff and is usually more expensive and time consuming to repair. In the worst case, the tail can strike the runway before the landing gear, thus absorbing large amounts of energy for which it is not designed. The aft pressure bulkhead is often damaged as a result.

Any one of the following landing risk factors may precede a tail strike:

Unstabilized Approach

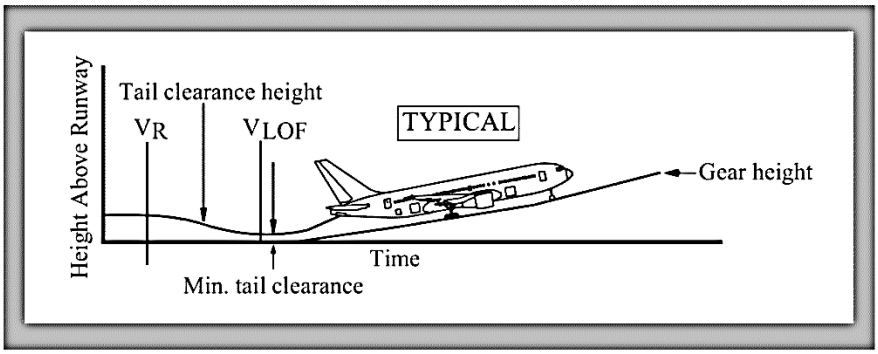
An unstabilized approach is the biggest single cause of tail strike. Flight crews should stabilize all approach variables - on centerline, on approach path, on speed, and in the final landing configuration - by the time the airplane descends through 1,000 feet AFE. This is not always possible. Under normal conditions, if the airplane descends through 1,000 feet AFE (IMC), or 500 feet AFE (VMC), with these approach variables not stabilized, a go-around should be considered. See the section titled “Stabilized Approach Recommendations” in chapter 5 of this manual for more detailed information on the stabilized approach.

Flight recorder data shows that flight crews who continue with an unstabilized condition below 500 feet seldom stabilize the approach. When the airplane arrives in the flare, it often has either excessive or insufficient airspeed. The result is a tendency toward large thrust and pitch corrections in the flare, often culminating in a vigorous pitch change at touchdown resulting in tail strike shortly thereafter. If the pitch is increased rapidly when touchdown occurs as ground spoilers deploy, the spoilers add additional nose up pitch force, reducing pitch authority, which increases the possibility of a tail strike. Conversely, if the airplane is slow, increasing the pitch attitude in the flare does not effectively reduce the sink rate; and in some cases, may increase it.

Figure 12 Boeing 737 FCOM

Typical Takeoff Tail Clearance

The following diagram and table show the effect of flap position on liftoff pitch attitude and minimum tail clearance during takeoff. Additionally, the last column shows the pitch attitude for tail contact with wheels on the runway and landing gear struts extended. For a discussion of tail strike procedures see Chapter 8 and the Tail Strike NNC.



Model	Flaps	Liftoff Attitude (degrees)	Minimum Tail Clearance inches (cm)	Tail Strike Pitch Attitude (degrees)
737-600	1	9.0	28 (71)	16.2
	5	9.0	28 (71)	
	10	8.8	29 (73)	
	15	8.7	30 (76)	
	25	8.6	32 (81)	
737-700	1	9.1	29 (73)	14.7
	5	9.1	29 (73)	
	10	8.9	30 (76)	
	15	8.7	31 (79)	
	25	8.5	32 (81)	
737-800	1	8.5	13 (33)	11.0
	5	8.0	20 (51)	
	10	7.6	23 (58)	
	15	7.3	25 (64)	
	25	7.0	29 (73)	

Figure 13 Boeing 737 FCOM

2.1.7. The FCOM cautions against pilots' inexperience due to non-familiarity with control response, especially when transiting from an aircraft with non-powered controls. However, in this scenario, the FO had sufficient experience on the type of aircraft as he had been with the airline for almost 4 years and had accumulated more than 1350 h on type. So, the occurrence cannot be attributed to inexperience or non-familiarity with the aircraft.

2.1.8. As per FCOM, the maximum pitch attitude for lift off is 8.5° which provides the minimum tail clearance of 13 inches (in) / 33 centimeter (cm) while the pitch attitude for a tail strike to occur during take-off is 11°. However, these limits apply when a pitch up rate of 2-3°/s is followed for take-off rotation. The FCOM also implies the possibility of a tail strike in case the rate of pitch is higher than normal.

2.1.9. **Runway Gradient** – The R/W in use at JIAP, Karachi at the time of departure was R/W 25L which has a downslope of 0.168%. As per calculation, this presents a downslope 0.09° angle which would add to the aircraft Angle of Attack (AOA) resulting in an overall increased AOA upon nose rotation for take-off.

2.1.10. **Abnormal Runway Contact (ARC)** – DFDR data analysis reveals that although the pitch attitude (9.5°) at the moment of lift off was higher than normal, but as per FCOM, still not so much as to result in a tail strike. The additional factor of slight downslope of the departure R/W is a contributory factor which served to increase the effective pitch angle. The effective pitch angle comes out to be 9.59° ~ 9.6° (9.5° aircraft pitch + 0.09° R/W slope); however, it is still lesser than the pitch angle specified for a tail strike. The decisive factor is the high rate of pitch while rotating the nose for take-off. The normal rate of rotation for take-off is 2-3°/s which ensures that the aircraft gets airborne while ensuring sufficient clearance of the tail from the R/W surface. However, the higher pitch rate of 4.2°/s resulted in reduced clearance from the ground at the time of lift off. While the pitch rate was not high enough to actually result in a tail strike, it was sufficiently high to cause the tail skid to just scrape the R/W surface at the time of lift off.

SECTION 3 – CONCLUSIONS

3.1. Findings

3.1.1. Serene Air Flight ER 522 was a scheduled passenger flight from JIAP, Karachi to AIIAP, Lahore.

3.1.2. Both Flight Crew were medically fit and held valid licenses to undertake the flight.

3.1.3. The aircraft had been loaded within the required CG limits (25.2%) with all up weight of 68.8 tons.

3.1.4. For the flight the FO was PF while the Captain was PM.

3.1.5. During take-off the Flight Crew heard an unusual noise which was assumed to be a bird hit.

3.1.6. All engine parameters, flight control response and cabin pressurization were as per normal limits; therefore, flight was continued.

3.1.7. Flight enroute and landing were uneventful.

3.1.8. After landing, the observation regarding the unusual noise during take-off was communicated to the maintenance crew.

3.1.9. During post flight inspection, the tail skid cover was found to be scratched with the green cartridge fully visible.

3.1.10. DFDR analysis revealed a high pitch rate of 4.2°/s with corresponding maximum pitch angle of 9.5° at the point of lift off.

3.1.11. The R/W of departure has a downslope of 0.168% which corresponds to an angle of 0.09°. This would result in an increment in effective pitch angle by 0.09° thus resulting in effective pitch angle as 9.59° (~9.6°).

3.1.12. As per B737-800 FCOM, tail strike can occur at pitch angle of 11°.

3.1.13. Although the aircraft pitch angle was less than 11°, the rate was pitch was 4.2º/s which is higher than normal. This caused the tail skid of the aircraft to just graze the runway surface as the aircraft was getting airborne.

3.1.14. A combination of high rate of pitch along with corresponding high pitch angle compounded by R/W downslope resulted in Abnormal Runway Contact (ARC) in the form of tail strike during take-off.

3.2. Causes / Contributing Factors

3.2.1. **Cause**

3.2.1.1. **Abnormal Runway Contact (ARC)** in form of tail strike during take-off.

3.2.2. **Contributing Factors**

3.2.2.1. High rate of rotation on take-off.

Note: *Aviation Occurrence Category (ADREP Taxonomy)*
"Abnormal Runway Contact (ARC): *Any landing or takeoff involving abnormal runway or landing surface contact.*
Events such as hard/heavy landings, long / fast landings, off center landings, crabbed landings, nose wheel first touchdown, tail strikes, and wingtip / nacelle strikes are included in this category."

SECTION 4 – SAFETY RECOMMENDATIONS

4.1. **Recommendations**

4.1.1. Aircrew may be given periodic refresher ground schooling regarding take-off and landing anomalies.