

# Technical report

## **IN-006/2021**

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Incident on 19 February 2021 involving an ATR 72-212 aircraft operated by Swiftair, registration EC-LYJ, at Palma de Mallorca Airport (Balearic Islands)

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MINISTRY OF  
TRANSPORT,  
MOBILITY AND  
URBAN AGENDA

CIVIL AVIATION ACCIDENT AND  
INCIDENT INVESTIGATION  
COMMISSION

## Notice

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident and its causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.6 of Regulation (UE) n° 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1 and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

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# ABBREVIATIONS

°	Sexagesimal degrees
°C	Degrees Celsius
%	Per cent
AEMET	Spain's State Meteorological Agency
AENA	Spanish Airports and Air Navigation
ATPL(A)	Airline transport pilot license (aircraft)
CEOPS	Operations Centre
CGA	Airport management centre
CIA/S	Companies
CIAIAC	Civil Aviation Accident and Incident Investigation Commission
COAM	Movement area operations coordinator
CVR	Cockpit voice recorder
FDR	Flight data recorder
FOD	Foreign object debris
ft	Feet
h	Hours
hPa	Hectopascals
IFR	Instrument flight rules
kg	Kilogrammes
km/h	Kilometres per hour
kt	Knots
LC	Line Check
LT	Local time
m	Metres
METAR	Aviation routine weather report
mm	Millimetres
MTO	Maintenance
No.	Number
ICAO	International Civil Aviation Organisation
OPS	Operations
p/n	Part number
psi	Pounds per square inch
QAR	Quick access recorder

R ..... Right (runway identification)  
RESA ..... Runway end safety area  
RWY ..... Runway  
OLS ..... Obstacle limitation surfaces  
s/n ..... Serial number  
TOAM..... Movement area operations technician  
TWY ..... Taxiway  
UTC..... Coordinated universal time  
WY ..... Weekly

# SYNOPSIS

Owner and operator:	Swiftair
Aircraft:	ATR 72-212 A, registration EC-LYJ
Date and time of incident:	Friday, 19 February 2021, 22:10 local time <sup>1</sup>
Site of accident:	Palma de Mallorca Airport
Persons on board:	Crew: 2, unharmed
Type of flight:	Commercial air transport- scheduled - domestic- cargo
Flight rules:	IFR
Phase of flight:	Take off - take-off run
Date of approval:	30/03/2022

## Summary of accident:

On Friday, 19 February 2021, at 22:10 h, the tread from tyre No.2 on the main landing gear of the ATR-72-212A aircraft, registration EC-LYJ, ruptured and separated on take-off from runway 24R at Palma de Mallorca Airport.

The aircraft continued with the scheduled flight between Palma de Mallorca and Madrid, with two crew members as the only occupants on board.

Upon arrival at the destination airport, the maintenance service detected the damage and notified the crew, who indicated that they had been unaware of the incident.

The crew of a flight taking off from Palma de Mallorca Airport on Saturday, 20 February at 8:07 local time reported the presence of tyre debris on runway 24R, initiating the runway cleaning process.

Both occupants were unharmed. The aircraft sustained minor damage.

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<sup>1</sup> Unless specified otherwise, all times in this report are local. On the day of the incident, local time was equivalent to UTC+1 hours.

## 1. FACTUAL INFORMATION

### 1.1. History of the flight

On Friday, 19 February 2021, aircraft ATR-72-212A, registration EC-LYJ, had taken off from Ibiza Airport with two crew members as the only occupants on board, for a cargo flight between Ibiza and Madrid, with an intermediate stopover in Palma de Mallorca.

The aircraft landed at Palma de Mallorca Airport at 21:00 h, and the operator proceeded to load the aircraft. According to the statements made by the crew, after carrying out the required inspections, they took off at around 22:00 h from runway 24R without incident.

The crew did not make any notes on the flight report, and the aircraft landed normally on runway 32R at Madrid-Adolfo Suárez Airport at approximately 23:30 h.

Subsequently, the maintenance service detected the missing tread and associated damage on wheel No. 2 of the left main gear and alerted the Madrid-Barajas Airport Management Centre to the need for a runway inspection at 00:19 h on 20 February. At 00:48 h, said centre reported that no debris had been found along the route taken by the aircraft to the parking stand, and it was decided that the operator would inform the aircraft's departure airport, Palma de Mallorca.

According to the crew, who learned of the event the following day when the company requested an explanation, at no point had they noticed anything unusual, neither during the landing nor subsequently while taxiing.

At Palma de Mallorca Airport on Saturday, 20 February at 8:07 local time, the crew of a flight taking off reported the presence of tyre debris on runway 24R, triggering the runway inspection and cleaning process.

Both occupants were unharmed. The aircraft sustained minor damage.

## 1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatalities				
Serious				
Minor				
Unharmed	2		2	
TOTAL	2		2	

## 1.3. Damage to the aircraft

The aircraft sustained damage to wheel No. 2 of its main landing gear, a flexible hose from the main landing gear actuator, the wheel-speed transfer assembly, the left main landing gear folding door, and an inspection panel. Rubber marks were also found in the areas near the landing gear, but these required no further action other than cleaning.

## 1.4. Other damage

None.

## 1.5. Information about the personnel

### 1.5.1 Information about the aircraft's personnel

The commander was 43 years old. He had an ATPL(A) license with a valid ATR 42/72 rating. His total flight experience was 7,920 h, of which 7,720 h had been in ATR aircraft and with the same company. His corresponding Class 1 medical certificate was also in force.

The co-pilot was 33 years old. He had an ATPL(A) license with a valid ATR 42/72 rating. His total flight experience was 409 h, of which 176:45 h had been in ATR aircraft and with the same company. His corresponding Class 1 medical certificate was also in force.

### 1.5.2 Information about the airport personnel

The Mallorca Airport runway and apron service that carried out the runway inspections between the incident flight and the flight that reported the presence of debris on the runway consisted of the following personnel:

## **Manoeuvring Area Inspection (Night-time) on 19/02/21**

A 54-year-old movement area operations technician with 30 years of experience.

## **Manoeuvring Area Inspection (Day-time) on 20/02/21**

A 30-year-old movement area operations technician with 4 years of experience.

A 54-year-old movement area operations technician with 31 years of experience.

### **1.6. Information about the aircraft**

The ATR 72-212 A model aircraft, registration EC-LYJ, s/n 468, operated by Swiftair, had a total of 39,944:45 flight hours and 16,784 cycles. It had two Pratt & Whitney PW 127 F engines. The left engine (number 1) with s/n PCE-AV0035, had 1,846:35 h and 1,419 cycles. The right (number 2) with s/n 127073, had 3,923:29 h and 3,848 cycles.

The aircraft's empty weight was 13,566 kg, and its maximum take-off weight was 23,000 kg.

The aircraft's weight and balance during the flight affected by the incident were within the limits established by the manufacturer.

The aircraft had the corresponding valid certificate of airworthiness.

#### **1.6.1 Condition of the aircraft before take-off**

Before take-off from Ibiza Airport, the aircraft was inspected by maintenance and later by the captain during the pre-flight inspection. This entails a visual inspection of the entire aircraft, including the wheels and tyres. The captain then accepts it, having verified the absence of anomalies.

Subsequently, the captain again accepted the aircraft following the requisite pre-flight/transit inspection at Palma de Mallorca Airport.

Neither of these inspections detected any issues with the aircraft's landing gear or wheels.

With regard to the scheduled maintenance inspections, the Line Check (LC)<sup>2</sup> and Weekly Check (WY)<sup>3</sup> were carried out on 17 and 18 February 2021, respectively.

The WY includes general visual inspections of different areas of the aircraft, including the landing gear, in addition to functional and operational tests.

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<sup>2</sup> Line Check.- routine inspection carried out every other calendar day

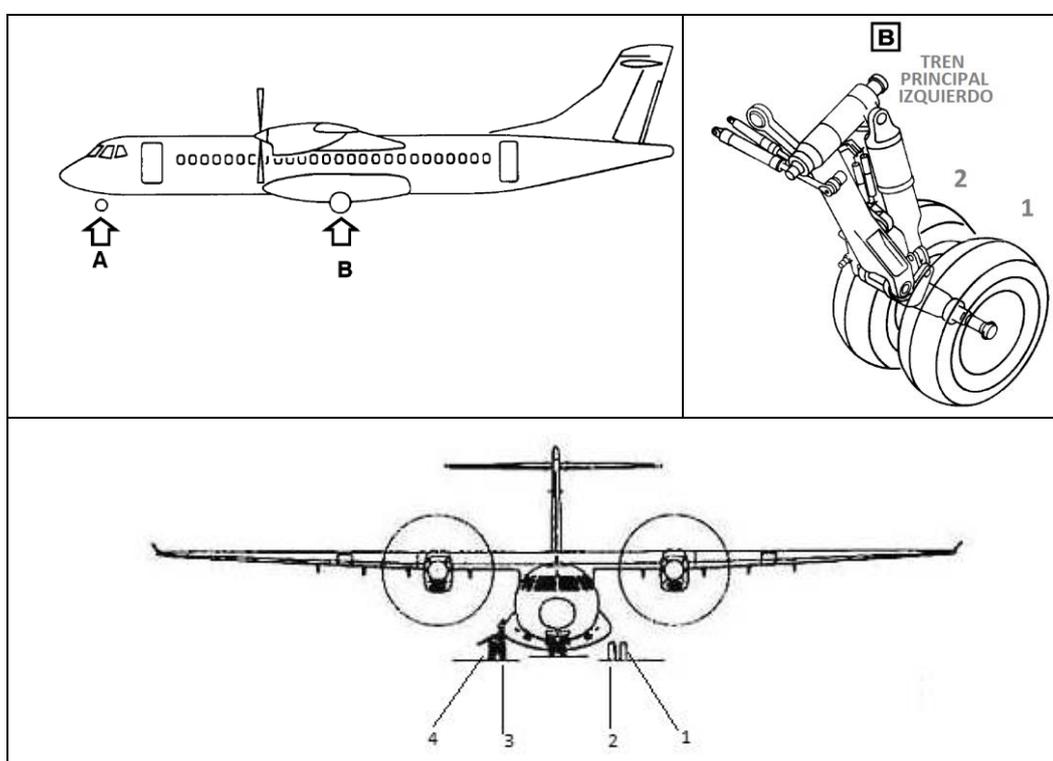
<sup>3</sup> Weekly - routine inspection carried out every 7 calendar days

The Line Check (LC) involves a series of tasks to check the general condition of the aircraft, the inspection and refilling of fluids and various system tests. The integrity and general condition of the wheels and tyres on the landing gear are checked through visual inspections and pressure checks, making adjustments if necessary.

The results of both inspections were satisfactory.

### 1.6.2 Information about the landing gear system

The ATR has retractable tricycle-type landing gear. It consists of two main units (B) and a nose unit (A). Each main unit consists of a trunnion-type leg, a drag strut and a separate shock absorber. It is fitted with a twin-wheel axle, two wheels per leg, and tubeless tyres. The main gear wheels are fitted with hydraulically operated multi-disc brakes.

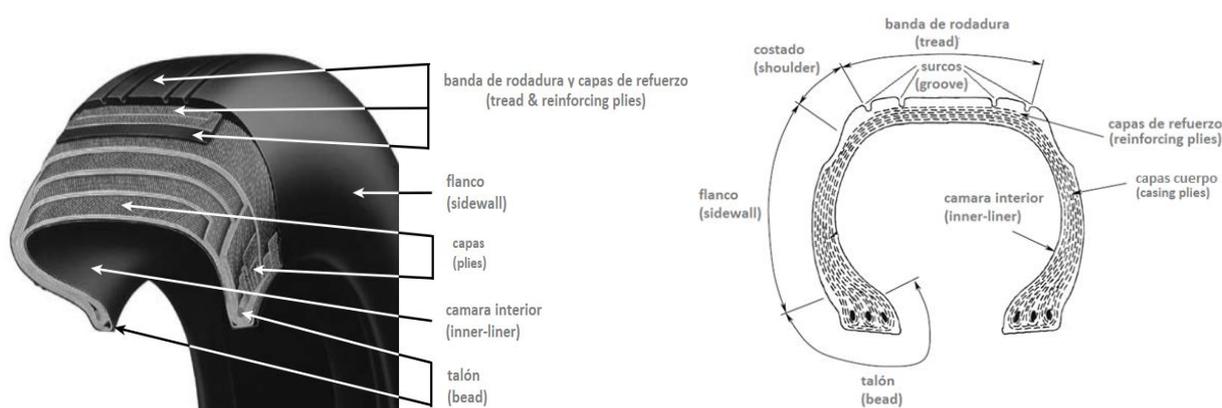


## Description of the wheel assembly

The wheel assembly comprises two aluminium alloy semi-rims and a 34x10.0 R16-14PR radial tyre. The semi-rims are joined by sixteen nut/bolt sets and a gasket that acts as a seal between the two. They also contain the inflation valve, a pressure relief valve to prevent overinflation and three fuse plugs to deflate the tyre should the brakes overheat.

The tyre is made up of:

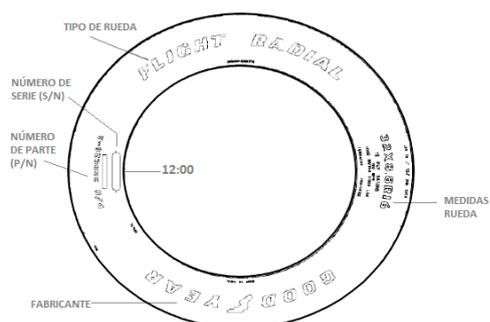
- the body of the tyre (casing), which is the whole of the tyre apart from the tread. It comprises a series of obliquely superimposed plies that provide resistance and uniformly distribute loads.
- the tyre tread: made of rubber, is the part of the tyre that comes into contact with the ground. This is the part of the tyre that undergoes retreading processes.



The tread has 4 grooves to indicate the level of wear and evacuate water.

Identification marks, such as the serial number or P/N, are located on one sidewall only.

To make it easier to identify the different areas of a tyre, they are divided into 12 identical sectors identified by time zones, with the serial number being located in the twelve o'clock sector when seen from the side it's marked on.



The wheel that lost its tread was wheel number 2; the tyre had part number 346Q48-4, serial number 50573651, and it had undergone a retreading process (R01)<sup>4</sup> in November 2019. The wheel-rim assembly with part number 90010812 and serial number 5038DF was installed on 23/04/2020, and at the time of the incident, it had accumulated 309 cycles and 489 hours.

The wheels are identified according to the criteria shown in the diagram, which shows that wheel number 2, which suffered the tread detachment, is the inner wheel of the left main landing gear.

### 1.7. Meteorological information

According to the information provided by the State Meteorological Agency (AEMET), the meteorological conditions in the area and at the time of the incident were no rainfall, wind gusts below 3 kt and good visibility.

The data recorded by the weather station at the head of runway 24R at Palma de Mallorca Airport between 21:00 and 21:30 UTC was as follows:

Time (UTC)	Wind		Gusts		Temperature (°C)	Rainfall (mm)	Pressure (hPa)
	Speed (kt)	Direction (°)	Speed (kt)	Direction (°)			
21:00	0.8	110	1.9	160	10.8	0.0	1020.8
21:10	2.2	100	2.9	110	10.6	0.0	1020.8
21:20	2.2	110	2.9	100	10.2	0.0	1020.9

<sup>4</sup> RL01.- Retread level 01- First retread process

The METAR reports before and after the time of the incident were as follows:

**METAR LEPA 192100Z 35001KT 9999 FEW010 11/10 Q1021 NOSIG=**

**METAR LEPA 192130Z 08003KT 9999 SCT010 10/09 Q1021 NOSIG=**

### **1.8. Aids to navigation**

N/A.

### **1.9. Communications**

After the flight, and once the tread detachment on wheel No.2 of the left main gear had been detected, a series of communications relating to the incident were initiated between the operator, Swiftair, and the Airport Management Centre at Madrid-Adolfo Suárez Airport.

According to the records provided by the airport manager, AENA, Swiftair reported the tread separation that had supposedly occurred on landing on runway 32R, on 20 February at 00:19 h; at that point, being unable to confirm whether it happened on the runway or the taxiway.

At 00:43 h, a notification was received from the COAM indicating that no tyre debris had been found on the route between the landing site on RWY 32R and parking stand 190, where the aircraft had stopped.

At 00:48 h, Swiftair was informed of the negative search result, and it was agreed that the operator would notify Palma to search there. The transcript of this conversation can be found in Annexe I

### **1.10. Information about the aerodrome**

Palma de Mallorca Airport has an elevation of 8 m (27 ft) and four runways (two parallel runway strips). The runway used for take-off by the incident aircraft was 24R, which measures 3,270 x 45 m.

## Runway inspection procedure at LEPA

Palma de Mallorca Airport has an established runway inspection procedure detailed in document IT00030, "COAM/TOAM Responsibilities". ~~Version 30, which was in force at the time of the event, was dated 31/05/2021.~~ The following information deemed relevant to the investigation has been extracted from the procedure:

There are two types of inspections: scheduled and additional.

Additional inspections may be motivated by accidents or incidents and after any unusual airport conditions.

### Regular/scheduled inspections

#### Manoeuvring area

A minimum of 4 inspections must be carried out: dawn (04 h to 10 h LT), midday (10 h to 16 h LT), dusk (16 h to 22 h LT) and night-time (22 h to 04 h LT).

The inspections shall include checks of the runway, runway side strip, taxiways, pavement markings, unpaved areas, obstacles in the vicinity of the airport and hazards caused by animals. The Manoeuvring Area Inspection Report (F\_00009) must be completed.

During inspections carried out under lighting, the manoeuvring area signs and lighting must be inspected.

Furthermore, during the night-time inspections, the lighting on any obstacles infringing on the Obstacle Limitation Surfaces (OLS) or located in the RESA, taxiway or runway strips inside the airport must be checked, and the Obstacle Lighting Inspection Report must be completed.

### Inspection criteria

Conditions permitting<sup>5</sup>, runway checks must be carried out in the opposite direction to take-off or landing, with the main-beam lights on and preferably with two marshalls, one on the right and the

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<sup>5</sup> If the direction of take-off or landing and the conditions prevent the inspection personnel from being able to see the runway clearly, they may carry out the inspection in the direction of landing.

other on the left. If the runway configuration changes during the inspection, the airfield must be abandoned immediately.

Given that deficient inspections may have consequences for aircraft safety, they must be carried out thoroughly and at low speed (recommended < 40 km/h) in order to detect any anomalies. If a low-speed inspection is not possible due to the interval assigned by the tower, it must be supplemented by additional checks whenever possible.

Inspection vehicles must always enter the runway via the holding points (H-1/2/4/5/6/7/8/9/10) and never via the No Entry points (S2, S1, N2, N3, N4, N5 and N7) unless expressly authorised by TWR.

Runway side strip and RESA checks must be carried out from the edge of the runway and entail a visual inspection of the 40 metres of levelled strip without leaving the paved area. The unpaved areas not checked during the runway and taxiway inspections must be inspected once per week.

### **1.10.1 Pre-take-off runway inspections**

According to information provided by the Airfield Service, the following runway inspections were carried out during the incident period:

Night-time: from 23:00 h to 23:15 h

Day-time: from 07:27 h to 07:35 h

### **1.10.2 Take-offs from runway 24R between the incident flight and the flight that reported the presence of debris on the runway.**

22:15 h: Take-off of the incident flight SWT-102.

22:45 h: Take-off of flight SWT-114

04:30 h: Take-off of flight SWT-117P

06:25 h: Take-off of flight SWT-112

06:55 h: Take-off of flight SWT-101

07:00 h: Take-off of flight VLG 91UB

08:00 h: Take-off of the reporting flight AEA-6012

The six aircraft that took off after the incident flight did so without incident. None of them reported having any problems with their landing gear.

### 1.10.3 Inspection of runway 24R after the debris notification

At the request of the TWR, the marshalling service carried out an unscheduled inspection between 08:15 h and 08:24 h, after the pilot of flight AEA6012 reported that he had possibly seen tyre debris on the North runway. Tyre debris was found between N3 and N5.

According to the Wildlife Control Service, the similarity between the tyre colour and the asphalt made it difficult for the marshalls to spot the debris on the runway at night.



Fig.1.- Illustration showing the contrast between the FOD and asphalt

In the absence of any further information, during the subsequent investigation, the companies operating the three preceding aircraft to use the runway were asked if they had experienced any type of incident involving their tyres. None of them had.

### 1.11. Flight recorders

Given the time that elapsed between the date of the event and the date of its notification to the CIAIAC, we have been unable to access the FDR and CVR recordings.

### 1.12. Aircraft wreckage and impact information

The aircraft landed normally and managed to taxi to its final parking position. Damage was identified to the left main landing gear, a flexible hose from the main landing gear actuator, the wheel-speed transfer assembly, the left main landing gear folding door, and an inspection panel.



Fig.2.- Landing gear folding door



Fig.3.- Actuator flexible hose



Fig.4.- Inspection panel y rubber marks

There were no perforations or damages to the fuselage or any of the aircraft's systems (tanks, hydraulic system, or electrical system), nor were there any fluid losses. The control surfaces remained operational.

Wheel no. 2 was still attached to the landing gear frame. It had complete tread loss and slight wear on one sector of the serial number side. In addition, frayed cords were observed along the entirety of its circumference.

On 20 February 2021 at 8:15 h, an additional unscheduled inspection was carried out on runway 24R at Palma de Mallorca Airport, as a result of which approximately 30% to 40% of the tyre tread was recovered. No non-wheel debris was collected.



**Fig. 5.- Wreckage of wheel number 2**

The sizes of the fragments recovered varied. All the recovered debris was preserved for further investigation (section 1.16). The other wheel on the left main gear (number 1) remained intact.



Fig. 6.- Recovered fragments of tyre tread

### 1.13. Medical and pathological information

N/A

### 1.14. Fire

There was no fire.

### 1.15. Survival aspects

N/A

### 1.16. Tests and research

#### 1.16.1 Records for wheel number 2

The tyre on wheel number 2 (p/n 3463Q048-4, s/n 50573651) was manufactured on 23/11/2015, fitted on the rim on 02/04/2020, and installed on the aircraft on 23/04/2020. At the time of the incident, it had undergone 1 retread process (R01) and 309 life cycles.

### **1.16.2 Records of the inflation pressures**

The following table shows the inflation pressures taken for all the main landing gear wheels during the line checks carried out in the run-up to the incident in February:

17/02/2021- Pressure main landing gear wheels 120 psi at 10°C

15/02/2021- Pressure main landing gear wheels 120 psi at 8°C

12/02/2021- Pressure main landing gear wheels 118 psi at 12°C

09/02/2021- Pressure main landing gear wheels 118 psi at 10°C

07/02/2021- Pressure main landing gear wheels 120 psi at 8°C

05/02/2021- Pressure main landing gear wheels 116 psi at 11°C

### **1.16.3 Review of the retreading process**

The records from the retreading process carried out on 26 November 2019 were reviewed. This review included the shearography tests carried out before and after the retreading process to confirm, initially, that the tyre is suitable for retreading and, once the process is finished, check for “non-adhered” areas inside the tyre that could lead to future integrity issues. This documentary and graphic review did not reveal any non-conformities or anomalies.

### **1.16.4 Reconstruction of the fragments of tyre number 2**

A detailed inspection of wheel No. 2 and, due to its proximity, wheel No. 1, was undertaken at the manufacturer’s facility.

Wheel No.1 was in good condition, with no anomalies seen in the tyre or the pressure gauge, which did not reveal any leaks.

With regard to wheel No. 2, no air leaks were detected by the gauge, and the sidewalls and beads of the tyre were in satisfactory condition, with no signs of separations between the different layers of material or internally within the material itself.

Once the recovered tread fragments had been reconstructed, a cut whose origin is compatible with the presence of Foreign Object Damage (FOD) was identified in sector 4 on the side of the tyre without the serial number.



A straight one-layer cut was visible on the inner-facing part of this area, which could have been made by a pointed object.



Based on these observations, we can establish that the tyre probably rolled over a foreign object that sliced through the tread's reinforcing layer in sector 4 and that the resultant centrifugal and radial forces caused its subsequent detachment.

### **1.17. Organisational and management information**

According to the information provided by Swiftair, all company personnel working at airports are aware of emergency procedures and, particularly, of the obligation to immediately inform the Airport Management Centre (PTRA Technician) by phone.

Swiftair's mechanisms/procedures for the prevention, detection and removal of FOD are established in the company's PO-SMS-005 and PO-MNT-229 on prevention and training in FOD. The documents stress the importance of early FOD detection as a fundamental tool to minimise its possible consequences and of identifying the source that generated it, thus avoiding repeat occurrences and reducing the associated risks (for example, lost bolts from aircraft, etc.).

### **1.18. Additional information**

N/A

### **1.19. Special investigation techniques**

N/A.

## **2. ANALYSIS**

### **2.1. General aspects**

On Friday, 19 February 2021, at 23:30 H, the ATR-72-212A aircraft landed at Madrid - Adolfo Suárez Airport having lost the tread on the No. 2 tyre of its main landing gear.

After the operator reported the incident to the Madrid Airport Management Centre at 00:19 h on 20 February, an inspection was carried out along the route taken by the aircraft but did not find any debris from the tyre.

At the aircraft's departure airport, Palma de Mallorca, the crew of a flight taking off reported the possible presence of tyre debris on the runway on Saturday, 20 February at 8:07 h.

A runway inspection was subsequently carried out, confirming the presence of tyre debris and triggering the process to remove it.

Our review of the aircraft's maintenance history did not identify any problems or abnormalities. With specific regard to the review of the retreading, no defects that could have weakened the tyre's internal structure were observed.

### **2.2. Of the meteorological conditions**

No conditions, such as crosswinds or high temperatures that could have affected the geometry of the tyre rubber while taxiing, were recorded.

### **2.3. Of the operation.**

According to the crew, the aircraft taxied normally, without the need for excessively sharp turns or manoeuvres that could have affected the wheel's structure.

According to the documentation provided by the operator, neither the weight and balance nor the inflation pressure records for the incident flight show anything to suggest excessive load on the landing gear.

Furthermore, there was no record of any previous issues that might have affected the proper functioning of the landing gear.

## **2.4. Of the wreckage**

Between 30% and 40% of the detached tread was recovered during the additional unscheduled runway inspection. A detailed analysis of the fragments revealed the presence of a cut whose origin is compatible with the tyre having rolled over a foreign object, initially puncturing the tread in sector 4 and subsequently causing it to detach completely.

The fact that no foreign object was found on the runway does not rule out the possibility that this may have caused the incident. In some instances, tyres may not fail immediately after puncture due to the circumstances involved in the event (impact energy, depth of the perforation) and the characteristics of the FOD (profile), which dictate the internal damage sustained and how long the tyre can resist. Therefore, an event of this type can occur several landings and take-offs after the tyre is punctured.

## **2.5. Of the management of the situation.**

In terms of the chronological development of the events, the following aspects stand out:

The crew did not notice the tyre tread detachment at any point.

The operator's maintenance staff detected the incident after the aircraft arrived at Madrid Airport, reporting it to the Madrid Airport Management Centre at 00:19 h. At 00:48 h, the operator's personnel were informed that no debris had been found, and it was agreed that they would report the event to the flight's origin airport, Palma de Mallorca.

Palma de Mallorca Airport, however, did not receive any notification in this regard until 08:07 h, when an aircraft that was taking off from runway 24R of said airport alerted them to the possible presence of tyre debris on the runway. It was only then that an unscheduled runway inspection was carried out, and the tyre debris was found.

Therefore, the runway remained contaminated for almost eight hours after the incident was first detected.

Although company procedure was initially followed and the appropriate notification made, it was not monitored until its definitive closure. We are, therefore, addressing a security recommendation to the operator, SWIFTAIR, proposing it establish the appropriate measures to ensure notifications are monitored until their definitive closure.

In a separate issue, two scheduled runway inspections, one between 23:00 h and 23:15 h and another between 07:27 h and 07:35 h, were carried out in the period between the incident flight taking off from Palma's runway 24R at 22:00 h and the take-off at 08:07 h, from the same runway, of the flight that reported the debris. Both were carried out by highly experienced personnel and in line with the airport's regulations on runway inspections, the first by one technician and the second by two. Neither found debris on the runway.

In this regard, irrespective of whether Palma Airport's runway inspection procedures are well-defined and comprehensive in terms of the means to be used and the criteria to apply, the capacity

to detect an object using visual inspection methods remains low. The problem stems from the fact that the inspections are visual and performed by one person, from a moving car that can travel up to 40 km/h and covers areas up to 30 m wide. In this case, the inspections were also carried out at night, and the objects to be located were the same colour as the asphalt of the runway itself. Obviously, the smaller the objects to be located, the more limiting these conditions are.

Palma Airport carried out runway inspection tests to check the capacity of personnel to find various objects, but despite knowing for sure the objects were there, they failed to locate all of them. It is clear that visual inspection methods are subject to limitations inherent to the human condition, making it impossible to guarantee that small objects will be detected.

Furthermore, studies on FOD indicate that small metallic objects are the most likely to be hazardous. However, the studies also show that they only account for a small percentage of all the FOD found on runways and that, in 80% of cases, they do not imply any consequences for aircraft operations, which explains why visual detection is still the primary method used at most airports, including Palma de Mallorca.

The new fixed and mobile FOD detection methods being developed are extremely expensive. Moreover, the fixed methods imply installing additional elements in the manoeuvring area, which could potentially compromise operational safety, and the mobile methods still need to be improved in terms of their execution times and ability to avoid false alarms.

Taking all these factors into account, we have decided not to issue any recommendations in regard to implementing new detection methods, but we are issuing a security recommendation to propose that Palma de Mallorca Airport study the possibility of improving the current inspection procedure.

### **3. CONCLUSIONS**

#### **3.1. Findings**

The aircraft landed at Madrid - Adolfo Suárez Airport having lost the tread on the No. 2 tyre of its main landing gear.

The incident occurred during take-off from Palma de Mallorca Airport.

The operator did not notify Palma de Mallorca Airport.

The crew did not notice the tyre tread detachment at any point.

Runway 24R at Palma was contaminated for a period of eight hours.

A cut, compatible with the presence of FOD, was found in sector 4 of the tread.

Neither of the two scheduled inspections detected the presence of debris on the runway.

#### **3.2. Causes/contributing factors**

The probable cause of the incident is considered to be the perforation of tyre number 2 on the left main gear by an external object (FOD), which caused the tread to detach.

#### **4. OPERATIONAL SAFETY RECOMMENDATIONS**

This incident has shown that, depending on the properties of the object to be located (size, colour, contrast...), using visual inspections to detect FOD on runways in reduced visibility conditions can be ineffective.

However, given that the newer detection methods, both fixed and mobile, still require further improvements, the following recommendation is issued:

REC08/21. It is recommended that AENA, as the provider of the Runway and Apron Service at Palma de Mallorca Airport, study the possibility of improving the detection of FOD on the runway.

Furthermore, in terms of the handling of the incident, the investigation found that the operator, SWIFTAIR, failed to report the incident to the departure airport, and therefore the following recommendation is issued:

REC09/21. It is recommended that SWIFTAIR implement the measures necessary to ensure that all incidents are monitored through to closure.