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INVESTIGATION REPORT

Accident to the Tecnam P2002-JF registered F-HFCM on 26 July 2015 at Compiègne aerodrome (Oise)

Time	20:01 (1)
Operator	Club
Type of flight	General aviation, dual-command training flight
Persons on board	Student pilot, instructor
Consequences and damage	Aeroplane severely damaged

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.

(1) Except where otherwise indicated the times in this report are local.

Fatigue failure of left main landing gear while taxiing during a training flight

1 - HISTORY OF THE FLIGHT

The student was performing a dual-command training flight to practice landing in cross winds. After a final touch-and-go, she returned to land on unpaved runway 23.

While taxiing, after the instructor had taken back the controls and was travelling up the runway, the left main landing gear failed.

2 - ADDITIONAL INFORMATION

2.1 Meteorological Information

Compiègne aerodrome does not have a weather station. The instructor estimated a 170° wind at approximately 15 kt before the start of the flight. The instructor explained that the wind had turned to 200° at 10 to 15 kt towards the end of the flight.

2.2 Personnel information

2.2.1 Student pilot

The student pilot, aged 38, had logged a total of 22 dual-command flight hours, of which 7 hours on a Jodel and 15 hours on a P2002. She had been authorised for solo flight on the P2002.

She had also obtained a fixed-wing microlight pilot licence in 2013, and had logged a total of 56 flight hours, of which 40 hours as pilot in command.

2.2.2 Instructor

The instructor, aged 70, obtained a private pilot licence in 1993 and his instructor's qualification in 2013. He had logged a total of 1, 400 flight hours, of which 145 hours on a P2002 and 452 hours as an instructor.

2.3 Witness statement

The instructor explained that the student had performed four aerodrome circuits. He stated that the cross wind landings were performed smoothly.

2.4 Aircraft information

The aeroplane was serial number 129. It was delivered new to the club in October 2010.

Following a hard landing in February 2014, the front landing gear, main landing gears and all attachment components were replaced at 1,090 flight hours.

At the date of the accident, the aeroplane had logged a flight time of 1,622 h 32 min.

2.5 Examination of the damaged parts

Each main landing gear (see diagram below) is composed of a leaf spring damper holding the wheel (1), which is attached to the fuselage by a central nut & bolt assembly (22-24) and a metal flange (19), which, in turn, is attached to the fuselage by two nut & bolt assemblies (25-27). A piece of leather (20), acting as a spacer and shock absorbent layer, is placed between the leaf spring and fuselage frame above this flange.

The left main landing gear's central attachment bolt (22) was found broken into two parts.

This bolt, along with the two bolts that secure the flange, the flange itself and the leather spacer, were taken for examination at the BEA laboratory.

All the equivalent attachments on the right main landing gear were also taken for comparison.

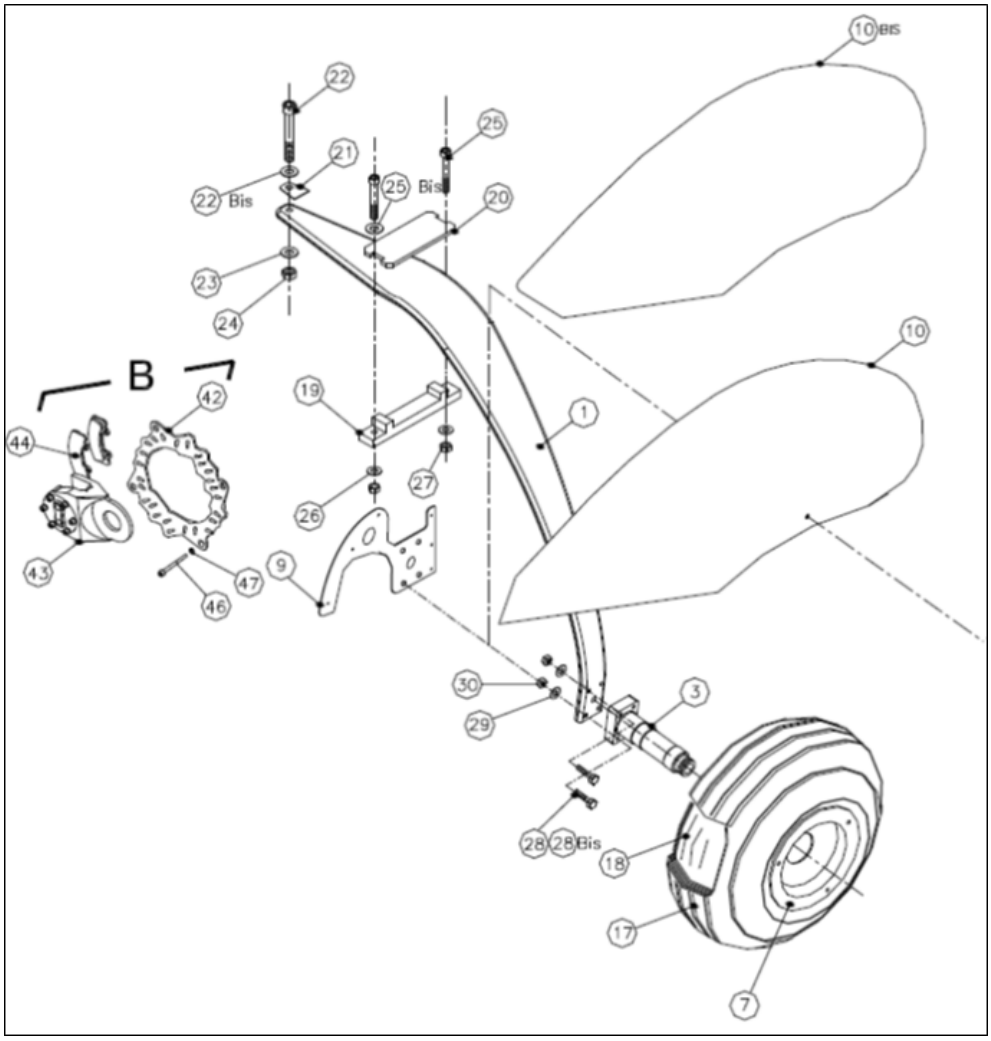

Figure 1: diagram of right main landing gear (taken from Tecnam P2002 Illustrated Parts Catalog)

2.5.1 Examination of left main landing gear attachments

The shank of the central attachment bolt had fractured approximately 33 mm below the bolt head (see below). The fracture zone showed no sign of deformation.

Circumferential markings were observed on the side of the bolt, and the bottom part showed traces of corrosion.

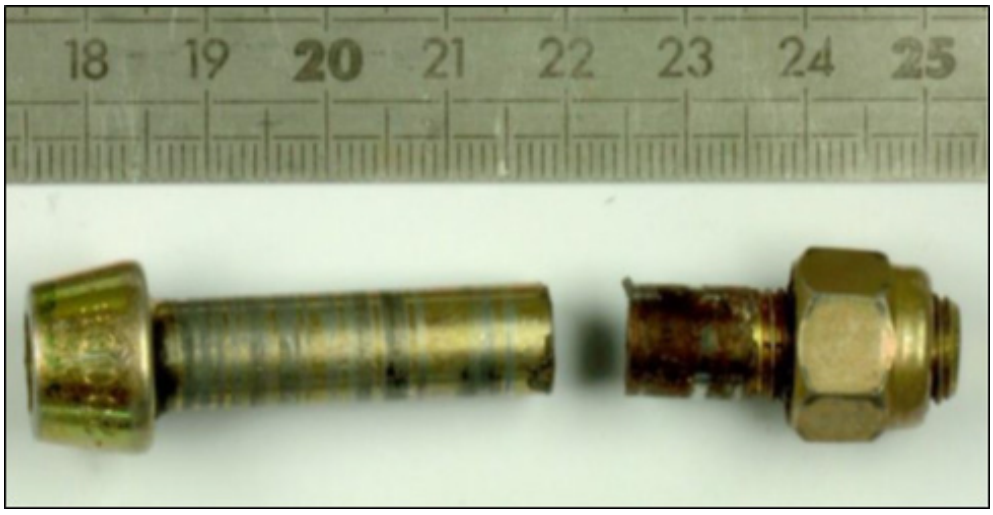

Figure 2: Broken left central attachment bolt

[2]Scanning Electron Microscope.

A SEM[2] examination of the central bolt found fatigue cracking in approximately 70% of the surface, which had propagated from diametrically opposed, multiple initiation sites around the bolt circumference. Such damage is characteristic of alternate bending loading.

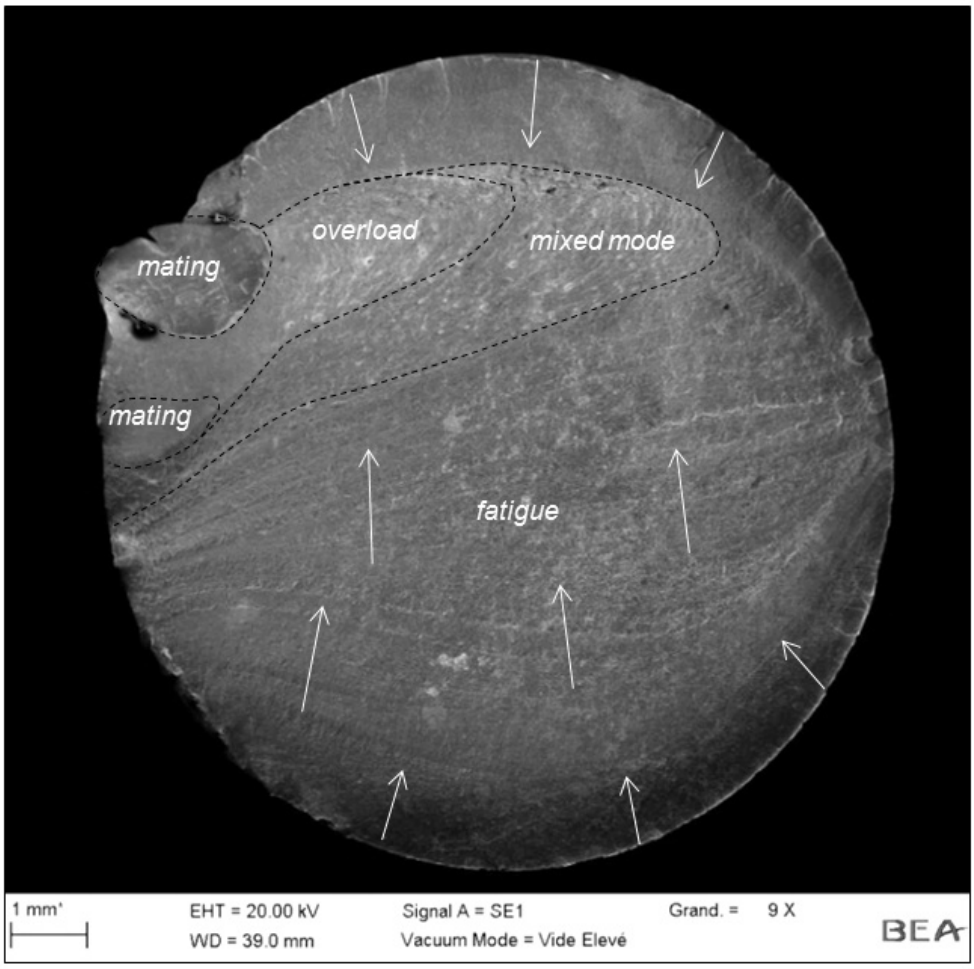

Figure 3: examination of the bolt failure, thread side

Metallurgical analyses of the left central attachment bolt showed that its composition complied with the manufacturer's specifications.

The two bolts holding the flange were bent following the failure of the attachment bolt and the collapse of the gear spring.

The left main landing gear flange was distorted. The flange bore on the bent side had become oval in shape. The leather spacer had split and had a flattened area on the surface in contact with the aeroplane frame.

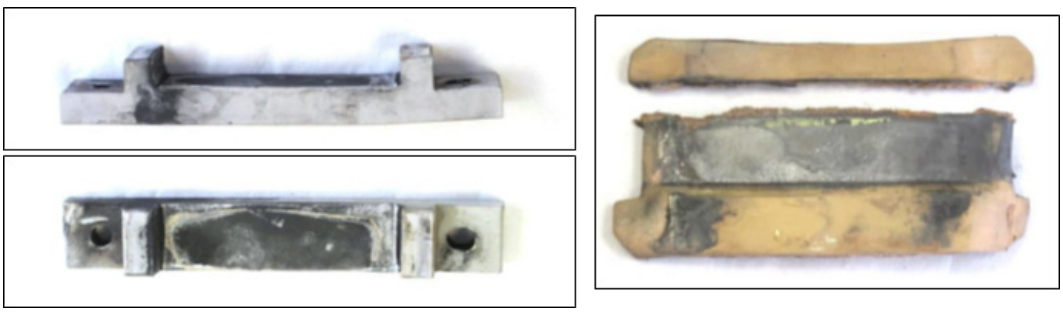

Figure 4: left main landing gear flange and leather spacer

2.5.2 Examination of right main landing gear attachments

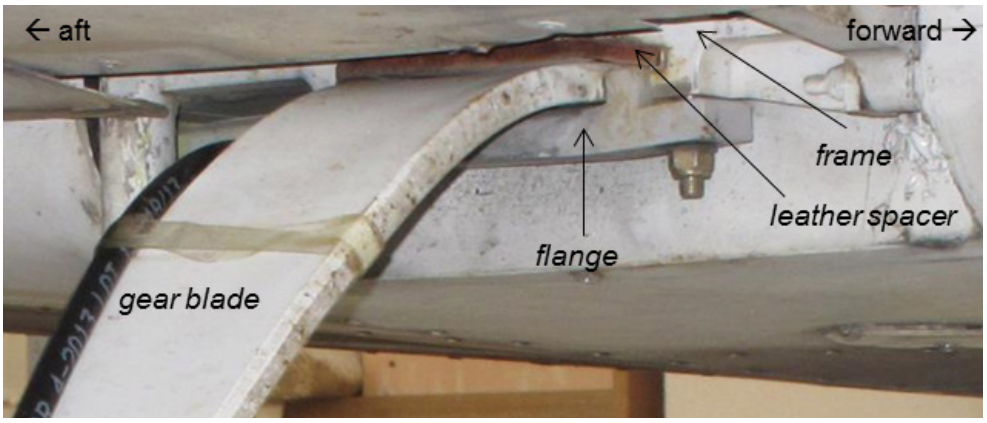

Figure 5: right main landing gear attachment before disassembly

The right main landing gear central attachment bolt was taken for examination. It had circumferential markings on its shank, approximately 33 mm below the head, in the same location where the left bolt had fractured. Between this marking and the head, numerous circumferential wear marks could be observed, as for the left landing gear bolt. A SEM examination showed a circumferential crack in the same location as the left bolt fracture.

Figure 6: central attachment bolt, left bolt above, right bolt below

The right main landing gear flange was deformed, in a similar way to the one on the left landing gear. In addition, the leather spacer had a flattened area on the surface in contact with the aeroplane frame.

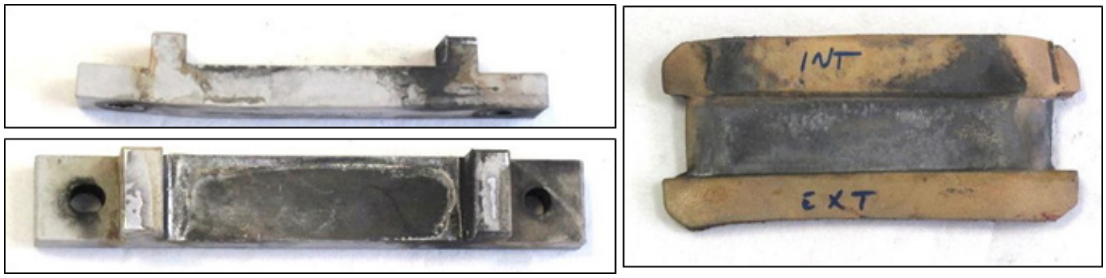

Figure 7: right main landing gear flange and leather spacer

The crack in the leaf spring central attachment bolt of the right main landing gear was opened up in the BEA laboratory. Examination of the fracture surfaces showed two diametrically opposed fatigue cracking areas, characteristic of alternate bending loading.

As for the left side, the metal composition complied with the manufacturer's specifications.

2.5.3 Conclusion of examinations

The examination of all the attachment components on the two main landing gear assemblies showed that:

- the attachment bolt of the left main landing gear had fractured due to a fatigue cracking process;
- the attachment bolt of the right main landing gear also had a fatigue crack in the same location as on the left main landing gear bolt;
- the damage observed was characteristic of alternate bending loading;
- the position of the cracks corresponded to the interface between the aeroplane frame and the landing gear leaf spring;
- the chemical composition of the material forming both bolts complied with the manufacturer's specifications;
- both bolts had markings between the head and the cracked area at the point where they were inserted into the aeroplane frame. This showed rotational friction between the bolt and frame;
- between the cracked area and the start of the thread, which was the point where the bolts were inserted into the landing gear leaf spring, marks showed the existence of friction between the bolt and gear leaf spring;
- the left and right flanges were deformed, showing abnormally high loads;
- the leather spacers had a compacted area corresponding to the indentation left by the aeroplane frame to which the leaf spring was attached.

2.6 Service bulletins and maintenance procedures

The Tecnam P2002 main landing gear is identical for all the manufacturer's two-seater aeroplanes (P92, P2002 and P2008). The four-seater P2010 is equipped with a different main landing gear, though its principle is identical.

Mandatory Service Bulletin (SB) No SB 066-CS Revision 1 was published by the manufacturer on 9 July 2012 following in-service damage to the main landing gears. The SB required a change in the type of nuts, with the nuts being replaced with stop nuts.

This SB was applied to F-HFCM on 31 July 2012, after 577 flight hours.

The maintenance procedures stipulated by the manufacturer require disassembly of the attachments and the main landing gear every 1,200 flight hours.

As of the date of the accident, the torque value of these bolts had to be checked every 100 flight hours.

At the time of its last 50-hour maintenance check on 10 July 2015, it had logged a total flight time of 1,627 h 26 min. In this maintenance check, it was not mandatory to check the torque value of the bolts.

The last 100-hour inspection, which included a check of the torque value of the bolts, took place on 22 May 2015. The aeroplane had at this point logged a flight time of 1,579 h 05 minutes.

On 28 September 2015, two months after the F-HFCM accident, Tecnam published SB No SB 214-CS, reducing the frequency of torque value checks to 50 hours for the main landing gear bolts.

Subsequently, this shorter 50-hour interval was introduced into the P2002 JF maintenance programme. The same interval was also applied in the P2008 and P2010 Aircraft Maintenance Manuals (AMM). Tecnam stated at this time that this reduced interval resulted from in-service experience.

More recently, in March 2017, the AMM for P2002 JF was modified: in addition to the check of the bolt torque value every 50 hours, new inspections must be carried out every 100 hours or every year:

TECNAM P2002 JF - Maintenance Manual

ATA	Item	Maintenance task	FREQUENCY				
			A	B	C	D	E
31	Indicating system	Inspect all instruments markings for their readability and wear.		X			
32	Landing gear	Inspect nose and main gear attachments, bolts and bushings for condition and security. Check especially for cracks, corrosion and damaged surface protection. Inspect for looseness, condition and security of mounting points.		X			
32	Landing gear	Examine the structure to which MLG and NLG assembly is attached. Check especially for cracks, nicks, cuts, corrosion damage, or any other condition that can cause stress concentrations and eventual failure.		X			
32	Landing gear	Inspect gear fairings for cracks, deformation, proper rigging, and general condition.		X			

Excerpt from P2002 JF AMM revision of March 2017

Furthermore, when carrying out the 50-hour check of the bolt torque value, the replacement of the leather spacers is now required if damage is observed.

The P2008 AMM which has the same landing gear has also been modified.

3 - LESSONS LEARNED AND CONCLUSION

The attachment bolt on the left main landing gear's leaf spring fractured as a result of fatigue cracking.

The corresponding bolt on the right main landing gear did not fracture, but had similar fatigue cracking.

In normal use, the leather spacer located at the interface between the fuselage frame and landing gear leaf spring is compressed under in-service loads. When the leather spacer is compressed, tightness is no longer nominal and play can appear. The main attachment bolt, which nominally works in tension, can then be subject to alternate bending loading. This loading is higher when the loss of flange tightness increases.

The oval-shaped bore holes in the flanges and the damage observed on the bolts were the result of abnormally high cyclic loads due to a loss of tightness of the assembly.

The accident occurred less than a hundred hours after the last check of the torque value of the bolts, and about 600 hours after the complete replacement of all the bolts. At the time of the accident, the complete disassembly required every 1,200 flight hours by the manufacturer was the only means of detecting an attachment with fatigue damage.

The more frequent check of the torque value every 50 flight hours, as initially recommended by the manufacturer after the accident, would not necessarily have made it possible to prevent the main landing gear bolt from failing. As there was no obligation to disassemble the main landing gear attachments, this check would not have detected a bolt with incipient fatigue damage. Re-tightening a bolt with incipient fatigue damage could even accentuate the damage.

The modification of the maintenance programme introduced in March 2017 by the manufacturer requires the inspection of the attachments and bolts every 100 hours which should allow a damaged bolt to be detected.