BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile
www.bea.aero
@BEA_Aero

INVESTIGATION REPORT

Accident to the Jodel D140 C Mousquetaire[1] registered F-BMBX

on 10 August 2016
at Salles-d'Argelès mountain landing area (Hautes-Pyrénées)

[1] Wood and canvas construction.

Time	Approximately 11:15[2]
Operator	Private
Type of flight	Mountain flight
Persons on board	Pilot and one passenger
Consequences and damage	Aircraft destroyed

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in October 2020. As accurate as the translation may be, the original text in French is the work of reference.

[2] Unless otherwise stated, all times given in this report are in local time.

Failure of wing during landing run on a mountain landing area

1 - HISTORY OF THE FLIGHT

The pilot, who was accompanied by a passenger, who was also a pilot, took off from Castelnau-Magnoac (Hautes-Pyrénées). The pilot indicated that he conducted a high and then low reconnaissance of Bergons mountain landing area (Hautes-Pyrénées)[3] in preparation for landing. The wind was light, but a little erratic. Another aircraft had just landed. After a stabilised final, the pilot carried out a three-point landing about 40 m beyond the runway threshold, slightly to the left of the runway centreline. During the aircraft's landing run, the pilot applied right rudder to return to the centreline. He heard a loud cracking sound. The aircraft veered sharply to the left and came to rest at the edge of the runway with the left wing broken. The pilot explained that the landing was firm, as is common with mountain landings, but not excessively so.

The owner of the mountain landing area saw the landing, which he felt was fine and not particularly hard. He saw the left wing break.

[3] Vallon du Bergons private mountain landing area, Salles d'Argelès (Hautes-Pyrénées), runway 33, average slope 17% (0% at bottom, 20% at top), altitude 3,445 ft.

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

Source: BEA

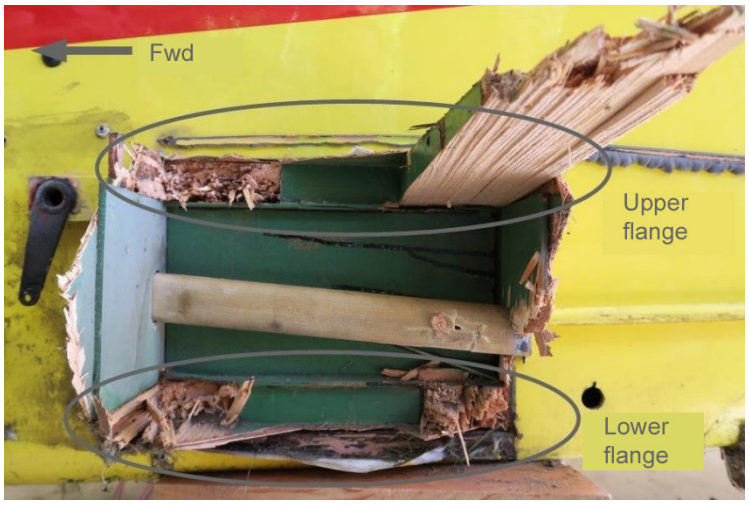
Figure 1: Wreckage of F-BMBX

2 - ADDITIONAL INFORMATION

2.1 Site and wreckage information

The landing marks showed that the aircraft carried out a three-point run over a distance of around 30 metres before the mark left by the left landing gear began to diverge from the other two wheel tracks. The first piece of wood debris was found nearby, a little further on in the direction of the aircraft's trajectory.

An initial examination of the wing was carried out on site. The failure of the left wing was located between the main landing gear and the wing-fuselage junction.



Source: BEA

Figure 2: View of the area of the wing spar failure, photo taken facing the fuselage

The wing was first examined at the BEA and then at an aircraft joiner's to determine the mechanical qualities of the materials and assemblies. During the visual examinations conducted at the BEA, an initial measurement of the moisture content in the wood flanges indicated a higher level on the lower left rear flange, near the wing root, than in the rest of the wing spar.

These examinations revealed the following:

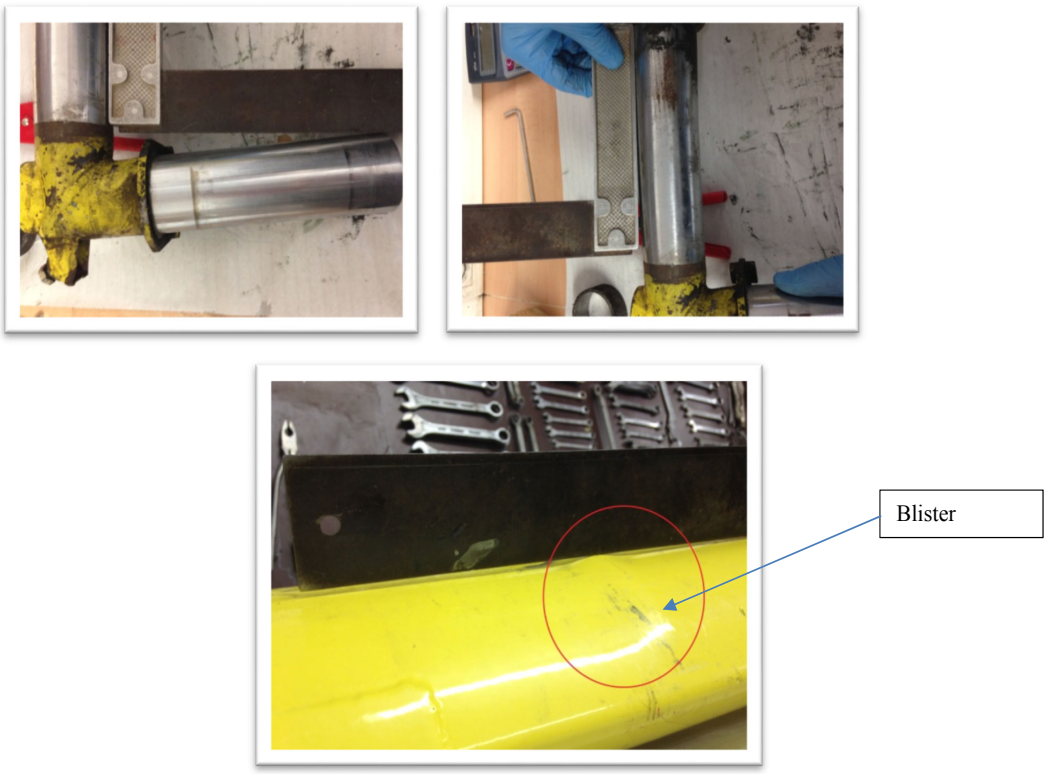
- The wing spar had failed in two places: at the left wing root and at the left landing gear attachment.
- The construction of the wing spar (wood used, gluing) did not show any anomalies that could explain the accident. No significant gluing defects were found.
- Traces of moisture were present both on the lower wing fabric covering near the wing root and on the structure, as well as on the inner sides of the fuselage. Moisture measurements were taken at various locations on the wing spar by the BEA and in the workshop several months after the occurrence. They showed that the highest levels of moisture, compared to the rest of the left side of the wing spar, were in the areas where the failure occurred, and were mainly located on the lower rear flange (Zone ZR4). Similar variations were also observed on the symmetrical part of the right wing.
- The resilience coefficients[(4)] found during the mechanical tests carried out on the specimens taken from the four flanges on both the fuselage and landing gear sides indicated that the wood used was at least "*first choice*" or even "*premium choice*". These results comply with the manufacturer's requirements.

The observations of the fracture faces suggest that the initial failure occurred on the lower left rear flange, in the area of the landing gear attachment.

The landing gear legs were examined at a workshop that is qualified to service this type of aircraft in the presence of the BEA:

- Both legs were deformed, indicating that they had been subjected to significant upward stresses. Some of these deformations could be seen with the naked eye or by touch (blisters on the lower attachment plate), or could be identified by pressing a square or ruler against the surface of the shock absorber. Deflection of the lower part of the shock absorbers and deflection in the area where the wheel axles fit into the legs were observed. The angles between the axis of the axles and the axis of the shock absorbers, which are normally 90°, were significantly reduced.

[(4)] Charpy pendulum impact tests to measure energy absorption. The main documents relating to woods, their characteristics, cuts and measurements are : - U.S. Bulletin ANC-19 (April 1951) "*Wood Aircraft Inspection and Fabrication*", - French standard NF L17-996 (March 1995), which specifies the technical conditions for the acceptance and use of rough-sawn lumber used in aircraft construction as well as the test methods.



Source: BEA

Figure 3: Deformations on the right landing gear

- The shock absorption quality was significantly degraded for both legs (significant friction, or even blockages, little or no lubricant). The permanent deformations observed on the landing gear legs were characteristic of abnormally high stresses. The impaired operation of the sliding rods probably contributed to this.
- The absence of a lubricator in the upper part of the shock absorbers was noted in relation to the manufacturer's drawing available from the workshop that carried out these examinations[(5)]. The threaded holes designed for the lower lubricators were present, but there were no lubricators. The deposits observed suggested that the absence of lubricators was not recent.

[(5)] It cannot be excluded that there are other, less common definitions of the landing gear.

2.2 Aircraft information and recent maintenance

F-BMBX (serial number 142) was manufactured in 1965. It was owned by several flying clubs and private pilots in the Île-de-France, Jura, Poitou, Alps, Drôme and Bouches-du-Rhône regions. It had been involved in four occurrences during landings prior to the Vallon des Bergons accident. The examinations carried out (see section 2.1) found no link between the failure of the right wing and these previous accidents or the repairs made as a result of them.

Other than these occurrences, an examination of the logbooks did not reveal any mention of a hard landing.

The pilot had owned the aircraft since 2013. He had filed a maintenance programme with OSAC[6], which was approved in September 2014. This programme provides for the following checks for the 100-hour or annual inspections:

- Landing gear: visual inspection of the landing gear legs for deformations and cracks. Visual inspection of the cylinders and axles for cracks; clearance, deformation. Check for tightness of the eight landing gear leg lower screws.
- Wings: visual inspection of the wings for impact deformation, condition of the fabric covering, trailing edge (drain grommets, no blockages).
- Wing spar: visual inspection of the landing gear attachments. (Bond separation, cracks).

The 2,000-hour inspections contain the same wording. No mention is made of the need for an in-depth examination of the wooden structure, possibly requiring removal of the fabric covering.

For the 50-hour inspection, the wording of the checks is identical except for the reference to checking the drain grommets and that they are not blocked, which does not appear.

In the event of a hard landing, this programme provides for the removal of the wheel spats, verification of the tyres and the condition of the wheels and axles, and an in-depth verification of the landing gear attachments.

The pilot indicated that, in August 2015, with the assistance of a mechanic, he had conducted a 100-hour inspection, during which he also removed and reassembled the main landing gear for overhaul purposes after observing "*blistering*" on the main landing gear legs. At the same time, the shock absorbers were removed and reassembled, as their condition was deemed to be acceptable. The checks described above were noted in the inspection record.

In the autumn of 2015, the pilot contacted people familiar with this type of aircraft to enquire about possible follow-up action in the wake of his observations. He realised that these deformations were likely the result of the stresses experienced during the aircraft's operation in mountainous areas. At the same time, a mountain instructor who had flown the aircraft informed him that the operation of the shock absorbers appeared to be abnormal.

The aircraft did not fly between 6 September 2015 and 16 January 2016. During this period, the landing gear was again removed for overhaul. The pilot indicated that the condition of the inside of the shock absorbers appeared to be acceptable. He had noted that he would probably, in the medium term, have to order new rubbers. The removed legs were sent to a maintenance workshop, where they were repaired and reinforced (metal reinforcements welded to the leading and trailing edges of the legs). The pilot then repainted and reassembled the landing gear legs. He then estimated the operation of the shock absorbers by alternately raising and lowering the wing tips[7].

[6] Civil Aviation Safety Authority.

[7] An appendix to an old flight manual provided by the workshop that examined the landing gear specifies dimensions to be measured with the aircraft parked and with the wheels off the ground. The pilot did not find these references in his aircraft documentation.

The airworthiness certificate was renewed on 15 January 2016.

A 50-hour inspection was conducted in early March 2016. The checks described above were signed off in the inspection record and a 100-hour inspection was conducted in July 2016. The airframe had logged 7,224 flight hours. The aircraft had flown approximately 10 hours between the end of this inspection and the accident.

The pilot added that, during the maintenance operations since becoming the owner, the angles between the axis of the axles and the axis of the shock struts were checked visually and no defects were reported. No measurements were taken. The aircraft was occasionally used with skis on snow-covered surfaces (the last time the aircraft had been used with skis was between February and April 2016).

The logbook does not contain any reference to a hard landing in the months preceding the accident. During the preceding 12 months, the aircraft had been used primarily by its owner. The aircraft was based at Aix-les Milles (Bouches-du-Rhône) and parked in a hangar.

2.3 Pilot information

The pilot held a valid private pilot licence and SEP rating. He had obtained a "*skis*" mountain rating in April 2011 and "*wheels*" mountain rating in October 2011. He had logged around 1,025 flight hours, of which about 290 hours were on type and about 200 hours in mountains.

2.4 Meteorological information

The meteorological conditions estimated by Météo France at the accident site were as follows:

- Northerly surface wind of 2 to 3 kt, visibility greater than 10 km, BKN 5,800 ft, temperature 14 °C, no turbulence.

3 - LESSONS AND CONCLUSIONS

Scenario

During landing, after touchdown, the left wing failed without the touchdown being violent.

Contributing factors

The mechanism that led to the failure of the left wing could not be precisely established by the investigation. However, the following factors contributed to it:

- shock absorbers in poor condition leading to the insufficient shock absorption property of the main landing gear, resulting in the transmission of abnormally high stresses to the wing spar;
- one or more firm or hard landings, which could not be dated.

The occurrence and exacerbation of these factors could not be precisely dated. However, the owner had detected signs (blistering on leg) without being able to make a definitive diagnosis, despite seeking information from mechanics and workshops.

Safety lessons

In general, it should be noted that visual detection of some landing gear deformations may not be easy without disassembling the parts and taking measurements. Similarly, the lack of accurate measurement of shock absorber travel does not facilitate decision making. Finally, for a pilot, in the absence of immediately visible damage and recording of the accelerations, the notion of a hard landing is subjective, especially in respect of mountain flying.

It could not be determined whether the localised moisture on the lower rear flanges had weakened the wing spar[8]. Detecting the presence of moisture is difficult because it requires access to the wing spar, but the wing does not have specific inspection hatches, particularly in the area where the failure occurred. In addition, it would require a measuring instrument tailored to making moisture measurements in wood. Moisture can be partly caused by activity on snow-covered surfaces.

This investigation shows that particular vigilance is required for old aircraft operating in the mountains that are exposed to humidity and snow and are maintained mainly by their owners, who are not necessarily aware of the stress and ageing of structures, particularly those made of wood. In addition, the maintenance programme might not include any instructions relating to in-depth examinations to detect damage to the aircraft structure or relating to acceptability criteria.

[8] Since the precise moisture measurements were made several months after the accident, it cannot be ruled out that the levels were higher at the time of the accident and that the wing parts dried out afterwards.