

No: 10/89

Ref: EW/G89/06/10

Category: 1c

Aircraft Type and Registration: DH82A Tiger Moth, G-ANCS

No & Type of Engines: 1 De Havilland Gipsy Major 1 piston engine

Year of Manufacture: 1939

Date and Time (UTC): 16 June 1989 at 1915 hrs

Location: Halvergate Marshes, near Great Yarmouth, Norfolk

Type of Flight: Private (pleasure)

Persons on Board: Crew - 1 Passengers - None

Injuries: Crew - None Passengers - N/A

Nature of Damage: Damage to engine, lower wings and landing gear

Commander's Licence: Private Pilot's Licence

Commander's Age: 44 years

Commander's Total Flying Experience: 662 hours (of which 320 were on type)

Information Source: Aircraft Accident Report Form submitted by the pilot and AAIB enquires

After a gentle descent from 1000 ft to about 500 ft, and whilst over Breydon Water, the engine suddenly began to shudder violently to such an extent that the pilot was in no doubt that it had to be shut down. This was carried out, by which time the pilot realised that the first available field was full of sheep and he was forced to accept a much rougher field for the forced landing. Despite attempting a full stall landing, the aircraft sustained damage to the landing gear, lower mainplanes, engine and forward fuselage.

From the pilot's initial examination of the aircraft it was apparent that the outer 6 - 12 inches of each blade of the wooden propeller had been seriously damaged, or was missing, and that little of its debris was present around the aircraft.

The remaining part of the wooden propeller, which is believed to have been manufactured in 1948, was sent to the AAIB for investigation. This, together with a specialist examination, revealed the following:-

The propeller was marked with the following information:-

RS/11/61, DRG J1.5220/1/18, Gipsy 111 and Major, D6 - 4.P4 - 9, LP 546.

Examination of the fracture faces showed that, on one blade, the fracture had run along a glue line between wood laminates where the glue was uneven in distribution. In addition, there was an absence of wood fibres on the upper face of this glue line. When dissected, it was noticed that three laminates in one blade offered little resistance to separation, particularly near the failure, and that in the other blade two laminates fell apart whilst the section was being sawn. Closer examination of these glue lines revealed that:-

- a) there were no wood fibres adhering to the top surface of the glue.
- b) the surface of adjacent laminates on any one glue line had glue present, indicating that both surfaces had been coated or that the transfer of glue from one surface to the other during pressing had been inadequate.
- c) the distribution of glue was uneven, and occasionally absent.
- d) the thickness of the glue line was variable, in some places very thin and in others quite thick. Where the glue was thick, it had a "crazed" appearance.

The wood used for this propeller was birch, in six laminates, and the adhesive was urea-formaldehyde (UF).

In addition, removal of the copper strip from the leading edge and dissection of the wood indicated the presence of oil penetration to a depth of 15 - 20 mm in several places. This appeared to be associated with screw holes or small cracks and indentations along the leading edge. The presence of spare screw holes indicated that this was not the original leading edge strip. Also, examination of all laminates at the point of failure indicated that in one blade, one laminate possessed markedly sloping grain, whilst in the other blade two laminates had sloping grains. This would have resulted in a 50% reduction in tensile strength, but the presence of adjacent straight-grained laminates would have reduced this effect.

Sloping grain, inadequate glue spread and uneven thickness of the glue line could not, together, satisfactorily account for the failure, since the propeller would have failed early in its service life. Thus these deficiencies were considered latent weaknesses, capable of contributing to the propagation of cracks once initiated.

With regard to the primary cause of failure, two factors would appear to have some significance:-

- 1) Loss in strength with time: Tests have indicated that UF adhesives in an unstressed state lose a high proportion of their initial strength, the amount depending upon the formulation of the glue. Even a good glue of the type used in aircraft construction has been found to lose up to 40% of its initial strength over a 40 year period, where stored under constant environmental conditions of 20°C /25%

RH. It is also known that such deterioration is accelerated at higher humidities, and especially so under cyclic changes in humidity.

2) Loss in strength under stressing: Laminated products, as well as solid wood, lose strength with time under load, usually of the order of 50% over 50 years. This may be insignificant in this case, but the effect is greater where the load is cyclic.

It was therefore considered that a combination of such factors probably accounted for this propeller failure, including inherent weaknesses in construction, deterioration in the glue with time and induced stresses in service.