DH88 Comet, G-ACSS

AAIB Bulletin No: 5/2004	Ref: EW/C2002/10/03	Category: 1.2
Aircraft Type and Registration:	DH88 Comet, G-ACSS	
No & Type of Engines:	2 De Havilland Gipsy Queen Series II piston engines	
Year of Manufacture:	1934	
Date & Time (UTC):	28 October 2002 at 1320 hrs	
Location:	Old Warden Aerodrome, Bedfordshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Right landing gear severely damaged, minor damage to right engine, nacelle and wing-tip	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	55 years	
Commander's Flying Experience:	10,130 hours (of which 26 were on type)	
	Last 90 days - 162 hours	
	Last 28 days - 65 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and Field investigations by the AAIB	

History of flight

The aircraft had been taken for a local test flight for the purpose of obtaining a Permit to Fly. Having completed, successfully, all the flight test requirements, the pilot made a approach to land on Runway 29. The pilot made his approach with the intention of making a touchdown on the main wheels in a nose-up attitude. The aircraft bounced four times and on the fifth touchdown, the right main landing gear collapsed. The aircraft sank onto its right wingtip and the underside of the right engine nacelle before sliding in a tightening arc to the right, coming to rest having turned through about 150° from its landing heading. The pilot stated that he had attempted to damp the bouncing of the aircraft by lowering the nose.

The aircraft was recovered by raising the right wing onto a dolly and towing it to a hangar.

An inspection of the grass runway showed that the surface was slightly undulatory but free from significant depressions. Examination of the wheel marks at each bounce position suggested that the aircraft had contacted the ground slightly more firmly on each successive touchdown. At the fifth touchdown point the aircraft appeared to have landed on its right mainwheel fractionally earlier than on the left and there was slight evidence of sliding of the tyre on the ground.

A series of still photographs, taken by an onlooker, showed that the aircraft had first touched down in a nose-high attitude and that the pitch attitude had reduced progressively at each successive touchdown. One photograph showed that the fifth touchdown was made on the right main wheel, and that the right spring strut had compressed to its limit just as the left wheel touched down. Subsequent photographs showed that the right landing gear drag brace mechanism articulated downwards at its centre hinge before any of its visible strut elements had distorted.

Description of the landing gear (see Figures 1 & 2)

DH88 Comet, G-ACSS, about to touch down

Photograph courtsey of Andy Ford

The main landing gear of the DH88 is retractable. It is mounted on a tubular steel mounting frame which is attached to the underside of the wing and which also serves as the engine mounting structure. The landing gear is raised and lowered by a screwjack mechanism driven through gears and shafting from a single, centrally mounted, electric motor. The range of movement is limited by microswitches in the right landing gear mechanism but there are no mechanical landing gear stops or locks, either 'up' or 'down'.

Figure 2: Landing gear in the extended position

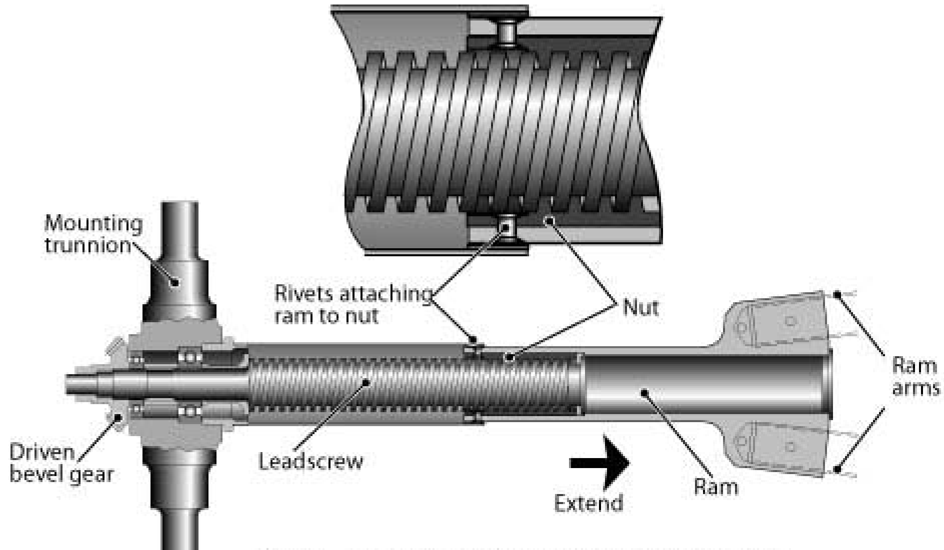

Figure 1 Section of landing gear screwjack actuator

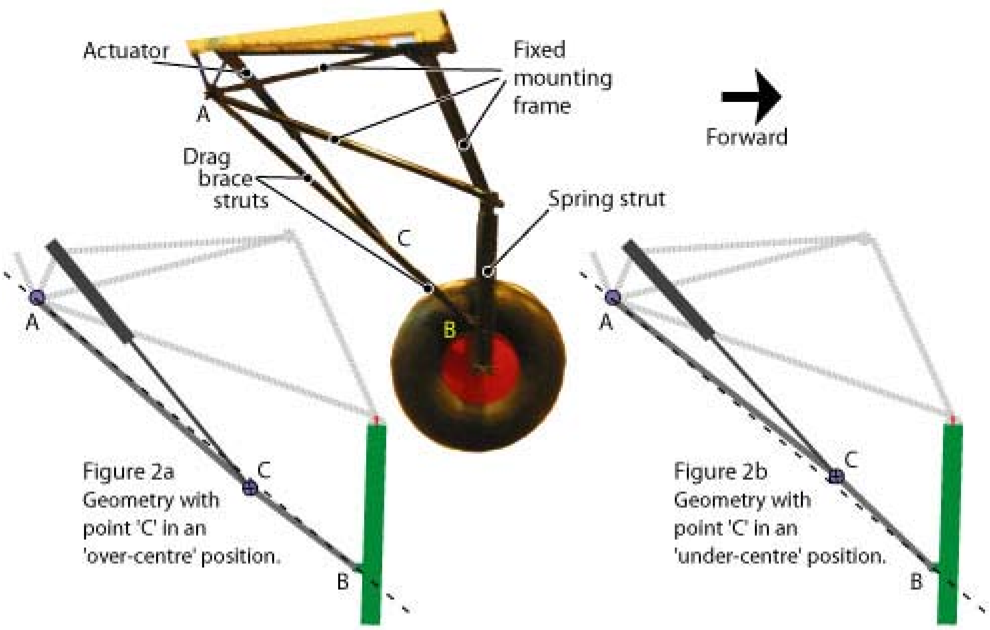

Figure 2 Landing gear in the extended position

Each main wheel axle is mounted on a pair of spring struts which are pivoted on the mounting frame. The lower drag brace consists of two parallel struts connected by a cross-tie, which is just clear of the tyre, pivoted near the bottom of the spring strut outer tubes. The two upper drag brace struts and the screwjack ram arms both link to the aft end of the lower drag brace and pivot about separate points on the rear of the mounting frame; the screwjack pivot axis being above that of the drag brace.

Within the screwjack, the driven nut is attached to the ram assembly by six $^{5}/_{32}$" mild steel rivets. These transmit the total force applied to the ram, through the screw into the mounting frame. According to the current rigging instructions, the down limit microswitch should be set so that, with the landing gear fully extended, the articulating joint of the drag brace assembly ('C') is just below the direct line between the points 'A' and 'B'. As a result, wheel drag loads will generate compressive loads in the drag brace struts which will, in turn, generate tensile loads in the screwjack assembly.

Examination of the aircraft

Examination of the failed right main landing gear elements revealed that the lower drag brace had bent downwards and backwards at the point coincident with the cross brace on that assembly. The upper drag brace struts had buckled nearer to their lower ends and the rivets attaching the screwjack nut to the ram had failed in shear in a direction consistent with a tensile force having been applied. There was evidence, within the landing gear bay, that, after the screwjack had parted as a result of the failure of the nut rivets, the freed end of the ram had pushed the jack body up into the underside of the wing and had subsequently punctured the engine oil tank in the rear of the right nacelle.

The underside of the right nacelle had been slightly crushed and the exhaust system flattened by contact with the runway. There was slight damage to the structure of the right wingtip.

Analysis

Analysis of the failure mechanism was based on the nature of the damage sustained by the landing gear structure and the photographic evidence available.

The photographic evidence indicated that the aircraft had made its first touchdown in a slightly nose-high attitude but that, as the pilot stated he had intended, each subsequent touchdown was at a less nose-up attitude and resulted in greater compression of the shock struts. The fifth touchdown, being at first on the right wheel only, resulted in the right landing gear spring struts appearing to 'bottom out' in compression.

Most probably this full compression of the spring strut, on the fifth touchdown, resulted in high wheel drag loads being generated. This, in turn, would have resulted in high compressive loads developing in the drag brace elements and it is probable that the longer upper drag brace struts became unstable and bowed. This would be consistent with the photographic record which showed the drag brace articulating downwards at its centre joint; continued articulation in that sense would have brought the lower drag brace cross-tie into contact with the wheel.

As a result of the drag brace geometry in the 'down' position, the high compressive loads developed in the upper drag brace struts would have generated considerable tensile forces in the screwjack. These appear to have been sufficient to shear the ram-to-nut attachment rivets. These compressive loads were also probably responsible for causing the aft ends of the lower drag brace to bend downwards whilst its cross-tie was jammed on the wheel.

Comment

It would be inappropriate to make a Safety Recommendation affecting this aircraft type but it is considered that the owners should consult the design authority on the advisability of adjusting the position at which the 'down' microswitch on the landing gear operates.

With there being no physical down-locks or mechanical 'over centre' blocks, the travel of the drag brace articulating joint, 'C', being positioned 'over centre' results in the generation of forces in the landing gear mechanism tending to drive the point 'C' further 'over centre'. If the landing gear were to be positioned with the point 'C' just 'under-centre', the resultant geometry would be stable and cause both the upper drag brace struts and the screwjack assembly to be in compression. The share of this compression between the elements would be related to the degree of 'under centre' set.

Such a change would affect the maximum compressive load that could be transmitted back to the airframe and the ramifications of this potentially greater load would have to be considered.