

**ACCIDENT**

<b>Aircraft Type and Registration:</b>	Diamond DA 42 Twin Star, G-OCCX	
<b>No &amp; Type of Engines:</b>	2 Thielert TAE 125-01 piston engines	
<b>Year of Manufacture:</b>	2006	
<b>Date &amp; Time (UTC):</b>	26 March 2009 at 0952 hrs	
<b>Location:</b>	Runway 21, Cranfield Airport, Bedfordshire	
<b>Type of Flight:</b>	Training	
<b>Persons on Board:</b>	Crew - 2	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Left main landing gear, left propeller, left engine and the left wing	
<b>Commander's Licence:</b>	Commercial Pilot's Licence	
<b>Commander's Age:</b>	66 years	
<b>Commander's Flying Experience:</b>	8,920 hours (of which 290 were on type) Last 90 days - 19 hours Last 28 days - 18 hours	
<b>Information Source:</b>	AAIB Field Investigation	

**Synopsis**

The aircraft suffered a left main landing gear failure while landing. A defect was identified which had not been detected during a previous special inspection of the failed area. No other instances of a defect remaining undetected following such an inspection were identified.

**History of the flight**

The student was carrying out a practice asymmetric approach in a 7 kt crosswind from the right. The instructor judged that the landing was normal except that the crabbed approach was not straightened. The aircraft touched down on the left main wheel, drifting to the left, before the instructor could intervene. Almost

immediately the left main landing gear collapsed and the aircraft veered off the runway to the left, coming to rest on the grass about 8 m from the runway edge.

The instructor shut down both engines and the aircraft electrics, after alerting ATC. Both occupants, who were uninjured, vacated the aircraft in the normal manner by raising the cockpit canopy.

Examination of the failed landing gear revealed that the attachment of its side brace to the primary structure had failed.

## Landing gear

The aircraft type has a primary structure fabricated largely from Carbon Fibre Reinforced Plastic (CFRP). Each main landing gear side brace attachment to its wing takes the form of a steel pivot pin, orientated fore and aft, with its forward end being bonded and encapsulated into a sandwich Glass Reinforced Plastic (GRP) assembly. The assembly has a dished profile, with flanges at its vertical edges and its lower horizontal edge, bonded to the aft face of the main-spar. The upper edge of the assembly forms a flange in a plane orientated parallel with, and bonded onto, the lower surface of the wing upper skin. The lower, side and upper flanges form a continuous bond line between the sandwich assembly and the wing CFRP primary structure.

## Examination of failure

Complete separation of the GRP assembly had taken place at the bond line. Examination of the failed bond area between the upper flange of the assembly and the underside of the wing skin revealed a large void ie a localised absence of bonding paste material. The void occupied approximately one third of the surface area of the joint between the GRP assembly and the wing skin.

## Mandatory Service Bulletin

The presence of voids in the bond between the sandwich assembly and the wing skin had previously been identified as a defective feature in some DA 42 aircraft before this accident. A Mandatory Service Bulletin (MSB), MSB 42-031, had been issued detailing an inspection procedure intended to identify this defect.

The MSB calls for extensive dismantling steps to be carried out to gain access to the critical area on each side of the aircraft. Thereafter, it requires three holes to be drilled through each upper flange of the sandwich

assembly at selected locations. The process of drilling and subsequent examination of the holes forms the procedure for assessing the presence, or otherwise, of bonding. If a bond defect is found, a repair/reinforcement procedure is specified.

The repair involves bonding in new specially manufactured sections which incorporate steps or joggles which permit them to fit over the outside of the GRP sandwich assembly. The sections are bonded to the sandwich assembly whilst their edge flanges are bonded directly to the under-surface of the wing skin and the aft face of the wing spar. In all cases the inspection holes are subsequently filled with resin.

The requirements of this MSB had been carried out on G-OCCX before the accident. Examination of the separated assembly from the aircraft revealed that two of the three holes had been drilled into a bonded area whilst the other had entered a void. The repair/reinforcement procedure, required if an area of no bond is found, had not been implemented.

## Inspection process

Once dismantling has been carried out to gain access, the MSB specifies a 4 mm diameter drill to be used for each hole. During drilling it is required to assess the changing drill torque or resistance behaviour. Initially the resistance is expected to be high, since the drill is cutting through the GRP laminate of the brace attachment assembly. It then decreases as the drill passes through the bonding paste. It then either increases significantly due to the CFRP laminate of the upper shell of the centre wing section being encountered or it decreases significantly before the drill hits the hard surface of the upper shell. In each case drilling must stop as soon as the upper shell is encountered, or before. In the first case the operative is required to

stop drilling immediately as the resistance increases. Alternatively, the resistance decreases significantly as the drill encounters the bonding paste void, then the drill hits the upper shell of the centre wing section. In this instance the operative is required to stop drilling as the resistance decreases ie before the upper shell is encountered.

The drill is then required to be removed and the hole inspected. If the bottom of the hole is the same colour as the bonding paste (light grey) then it is assumed that a correct bond exists. If, however, only black glossy surfaces are visible it is assumed that no bond material is present and no structural bond exists. In such a case, a repair/reinforcement is called for.

#### **Other incidents**

The manufacturer stated that they had had good success with the MSB and were aware of only one other case of a landing gear failure following the application of the repair scheme. In that instance, they reported that the repair “ribs” had been poorly bonded during the reinforcement procedure.

#### **Development of the inspection procedure**

The manufacturer stated that when they developed the inspection procedure they wanted to make it as simple as possible, using standard tools, because more sophisticated methods, such as ultrasonic inspections, required experienced personnel to interpret the results correctly. The concern was that trained personnel with those skills would be scarce in general aviation. The inspection procedure as detailed in the MSB was satisfactorily tested on their production and maintenance staff.

The manufacturer considered requiring all DA 42 aircraft to be equipped with the additional “ribs” but

investigation revealed that there was a significant number of unaffected aircraft and to do so would impose a weight, time and cost burden on the owners.

#### **Discussion**

The presence of voids in the bond between the sandwich assembly on the main landing gear side brace attachment and the wing skin had previously been identified as a defective feature in some DA 42 aircraft. A Mandatory Service Bulletin (MSB), MSB 42-031, had been issued detailing an inspection procedure intended to identify this defect.

MSB 42-031 had been carried out on G-OCCX. A void in the bond existed in the attachment for the left main landing gear side brace but the repair/reinforcement procedure had not been completed. Subsequently the main landing gear failed during the landing on the accident flight.

No other instances of a defect remaining undetected following the MSB procedure were identified. However, the manufacturer was aware of one case of reinforcement ribs being poorly bonded during the application of the MSB repair procedure on one aircraft and the landing gear subsequently failing.

The manufacturer had considered more sophisticated examination techniques when developing the MSB but concluded that this procedure, using standard tools, was the most appropriate.

#### **Conclusions**

The left main landing gear collapsed during a practice asymmetric landing as a result of the failure of the bond between the sandwich assembly on the main landing gear side brace attachment and the wing skin. This was attributed to a void in the bond for which the repair/

reinforcement, detailed in MSB 42-031, had not been completed, although the MSB had been carried out on the aircraft. The MSB had been developed to identify this defect.

The manufacturer was aware of one other case of a landing gear failure following the application of this repair scheme. In that instance, it was reported that the repair “ribs” had been poorly bonded during the reinforcement procedure.