Airframe vibration during climb, Boeing 747-236B, G-BDXJ, 18 June 1996

Micro-summary: During climb, this Boeing 747-436 experienced airframe vibration. A diversion commenced; the problem was a missing wing panel.

Event Date: 1996-06-18 at 2130

Investigative Body: Aircraft Accident Investigation Board (AAIB), United Kingdom

Investigative Body's Web Site: http://www.aaib.dft.gov/uk/

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Boeing 747-236B, G-BDXJ, 18 June 1996

AAIB Bulletin No: 10/96 Ref: EW/C96/6/6 Category: 1.1

Aircraft Type and Registration:	Boeing 747-236B, G-BDXJ
No & Type of Engines:	4 Rolls Royce RB211-524D4 turbofan engines
Year of Manufacture:	1980
Date & Time (UTC):	18 June 1996 at 2130 hrs
Location:	During climb, near London Heathrow
Type of Flight:	Public Transport
Persons on Board:	Crew - 18
	Passengers - 298
Injuries:	Crew - None
	Passengers - None
Nature of Damage:	Damage to left wing inboard upper trailing edge panel
Commander's Licence:	Not relevant
Commander's Age:	Not relevant
Commander's Flying Experience:	
	Last 90 days - Not relevant
	Last 28 days - Not relevant
Information Source:	AAIB Field Investigation

During the climb phase of a flight from London Heathrow to Delhi, a moderate airframe vibration became apparent on selecting Flap 5° to Flap 1°, and continued during selection from Flap 1° to zero. The vibration level reduced to 'slight' after flaps up until passing FL 265 at Mach 0.83, when moderate airframe vibration returned. The aircraft was levelled at FL 270 and the speed reduced to 310 kt IAS, whereupon the vibration level again reduced. The decision was made to dump some 50 tonnes of fuel and return to Heathrow. Vibration was again experienced as the flaps were selected from 0° to 1°, and increased on selecting 5°. However the vibration level decreased with further flap selection and decreasing speed. An uneventful landing was made, and a subsequent inspection revealed that a section of the left wing trailing edge upper inboard panel was missing.

Examination of aircraft

The panel in question (often referred to as the 'flying panel') formed part of the fixed wing trailing edge above the inboard flap (see the attached diagram and photograph) and was constructed of glass fibre skins around a Nomex honeycomb core. During flap retraction, the panel is deflected upwards by the fore-flap loading the underside at the inboard end. The panel is supported by a torsion bar assembly which is rigged to give a downwards pre-load when the flaps are retracted. This ensures a snug fit of thefore-flap against the panel, and thus provides an aerodynamic seal.

A large section of the inboard trailing edge of the panel, extending approximately 2m in span and 0.7m wide at the wing root end, had broken away. A large tear, and several minor tears, were apparent on the upper surface of the fore-flap. In addition, the detaching panel fragments had caused minor scuffing on the mid and aft flaps, and on the paint on the aft fuselage. Beneath the panel, one of the torsion bar support struts had failed in compressive overload.

Examination of the panel indicated that the damage had initiated in the bond between the upper skin and the core, and was associated with previous repairs. A laboratory examination was conducted on parts of the panel containing the repairs, and it was found that a spanwise 'wrinkle' was present in the upper skin, and that this had occurred as a result of a partially filled region of honeycomb. Damage to the underside of the upper skin indicated that it had suffered fretting damage due to contact with the fore-flap. This in turn suggested that the panel failure had been progressive, as opposed to the missing portion having become detached instantaneously. Additional examination of the wrinkled area indicated that the filler had not penetrated to the full depth of the honeycomb cells, and that it had broken up into blocks. It was apparent that a further repair had been carried out, involving a honeycomb insert. However, no attempt had been made to join the inserted plug to the surrounding core. All repairs had been carried out using cold setting adhesives. There was no evidence of the failure having been caused by moisture ingress.

It was concluded that the failure probably occurred due to a localised change in stiffness in bending caused by the presence of filler in the core. It is probable that pieces of the panel became detached after the aircraft took off, with additional damage occurring as the flaps were retracted. This would have brought the fore-flap into contact with the broken trailing edge of the panel, crushing it in a chordwise direction, with consequent downwards deflection, thereby damaging the torsion bar assembly.

Panel history

The airline stated that sometime prior to September 1995 the panel had been the subject of a repair in accordance with the Boeing Structural Repair Manual (SRM). The full details of the repair were not available, but the SRM provides for a variety of repair methods. On 2nd October 1995, a Design Deviation Authority (DDA) was raised to allow the aircraft to remain in service with a crack that had appeared from the SRM repair. The DDA system is a CAA approved procedure that allows the airline to design and implement repair schemes that constitute minor deviations from the aircraft manufacturer's processes or drawings, in this case the SRM. The action associated with this particular DDA was to mark the crack with ink to allow subsequent checking for propagation, and to tape the crack up to prevent moisture ingress. The DDA also called for re-inspection of the panel at each Ramp 2 check (every 190 hours, or approximately 16 days), and repair of the crack at the next S2 check, which was due in December 1995.

In the event, an additional DDA was raised on 9 October 1995 to repair the delamination that had occurred around the original repair, and the cracking. This DDA called for a temporary, 'on the wing' repair of the delaminated area, to be inspected at each Ramp 3 check (every 540 hours, or

approximately 45 days), with terminating action, in the form of Modification 57G012, to be carried out at the next Inter check, due in December 1996. The repair that was done as a result of the later DDA was seen as terminating the requirement both for the repeat inspections, and the repair called up in the earlier DDA. The airline stated that at least two 540 hour inspections were performed on the panel before the incident occurred, with no defects being reported.

Modification 57G012 was the airline's designation for Boeing Service Bulletin SB 747-57-2289, issued in July 1994. The text of the SB noted that there had been 93 cases of the subject panel breaking up and departing the aircraft. Two of these occurred to Boeing 747 aircraft G-TKYO and G-BDXH, and were reported in AAIB Bulletins 8/92 and 2/95 respectively. The modification introduced a redesigned and strengthened panel, which is being embodied across the fleet on an attrition basis.

The scheduled inspections on these panels (both pre and post modification), consist of visual and 'tap' inspections for delamination and cracking, during every S2 check.

Safety action

As a result of this incident, a Special Check was raised by the operator to inspect and repair, as required, all trailing edge flying panels within one calendar month for all aircraft with SRM repairs, and at the earliest possible service interval for all other aircraft. In addition, it was decided to cease deviations from the SRM using the DDA system, as far as this panel was concerned,and the SRM was amended to permit no cracks.

The airline considered that panel damage could also result from maintenance personnel walking on the panels during inspection and servicing. To reduce this problem, all panels are to be placarded "NO STEP", and Modification 57G012 was raised in issue to show the same placard. Additionally, it is intended to publicise the problem of damaged panels in an issue of an in-house technical newsletter.