Boeing 747-236B, G-BDXI

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Aircraft Type and Registration:	Boeing 747-236B, G-BDXI
No & Type of Engines:	4 Rolls-Royce RB211-524D4-19 turbofan engines
Year of Manufacture:	1980
Date & Time (UTC):	5 October 1996, time not known
Location:	On departure Delhi Airport, India
Type of Flight:	Public Transport
Persons on Board:	Crew - 17 - Passengers - 321
Injuries:	Crew - Nil - Passengers - Nil
Nature of Damage:	Damage to the right wing fixed trailing edge upper panel and the fore and mid trailing edge flaps
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	13,210 hours (of which 709 were on type
	Last 90 days - 193 hours
	Last 28 days - 64 hours
Information Source:	AAIB Field Investigation

During climb-out from Delhi, at about 500 feet and following theinitiation of a turn to the left, the flight deck crew felt anunusual vibration. A short time later the cabin crew reportedthat there was a 'bad vibration' in the cabin between doors 3and 4 on the right-hand side. A member of the flight deck crewwent back into the cabin to investigate and heard a loud noiseabove the overhead bins, and felt a vibration through the floor.The vibration subsequently appeared to be speed-related and onreaching the cruise Flight Level the vibration decreased and stopped.After the subsequent arrival at Heathrow Airport, it was foundthat a large area of the right-hand wing Fixed Trailing Edge UpperPanel, also known as the 'Flying Panel', was missing and inboardareas of the upper surfaces of the fore and mid trailing edgewing flaps were badly damaged. Subsequent examination of the damagedareas showed good evidence to indicate that the Flying Panel hadbeen 'hammering', for a period of time, against the fore flapand had produced two deep grooves in the fore flap's upper surface.No evidence was found to indicate that any defect in the structureor material of the Flying

Panel had contributed to its failure.A major repair of this Flying Panel had previously been carriedout, but there was no evidence that the type, or standard, ofthe repair had contributed to failure of the panel. Below theFlying Panel, it was found that the inboard diagonal tie rod atrib 1 (Figure 1)had bent/bowed laterally outboard in compression and had failedacross the lower drain/vent holes. Metallurgical examination ofthe tie rod showed that it had failed in low cycle/high stressbending fatigue indicating that the force, which had caused therod to bend, had been of a cyclic nature. The number of bendingcycles was assessed as being in the order of 160 to 240 cyclesfrom crack initiation to final failure. Examination of the tierod also indicated that the rod had previously been adjusted toextend its length. This adjustment appeared to have been accomplishedwith a 'Stilson/pipe-wrench' type of tool on the external surfaceof the large diameter area of the rod. Between the 26th Februaryand the 23rd May 1996, the aircraft had undergone a major maintenancecheck at an aircraft engineering organisation in Australia. Examinationof the maintenance documentation for the aircraft did not revealany evidence of subsequent work having been carried out that wouldhave necessitated the adjustment, or rigging, of the Flying Panelsince the maintenance in Australia. The aircraft had performed230 flights between the maintenance in Australia and the dateof this incident. Chapter 57-22 of the Maintenance Manual containsthe information about the removal, installation, adjustment andrigging of the Fixed Trailing Edge Upper Panel. A number of pre-conditionsand warnings are given throughout the chapter, one of which statesthat "*Adjustment of the fixed trailing edge upper panelis made with the airplane on the gear----".* An AAIB Inspectorwas present with the operator's engineering staff when the replacementFlying Panel was fitted and rigged. It was noted that the proceduresin Chapter 57-22 of the Maintenance Manual were very difficultto follow and in areas were ambiguous. The operator gave assurancesthat the procedures would be reviewed. However, as a result ofthis review, the operator decided that no revision of the MaintenanceManual was required. It was noted that there have been three otherincidents of inflight break-up of the Fixed Trailing Edge UpperPanel which AAIB have investigated (AAIB Bulletins 8/92, 2/95and 10/96). One of these incidents also involved an inboard diagonaltie rod that had failed in compressive overload. Discussion Itwas concluded that the initiator of this incident was a largecompressive force which had been applied to the inboard diagonaltie rod, resulting in bending of the rod. Over a period of time,the compressive force was successively removed and then reappliedresulting in failure of the rod after some 160 to 240 cycles,which then allowed the inboard trailing edge of the Flying Panelto lose its rigged form and contact the upper surface of the foreflap. The upper end of the tie rod was attached to the FlyingPanel and the lower end was attached to the lower rear area ofthe main landing gear beam. It is considered that the large forcesrequired to bend and fail the tie rod were generated by the tierod being incorrectly adjusted, possibly whilst the airplane wason jacks and then, when it was lowered onto its landing gear,the deflection of the main landing gear beam produced a compressiveload in the tie rod. Each time thereafter that the aircraft took-offand landed the compressive force would have been removed and reapplied,producing the fatigue striations observed in the failure surfacesof the tie rod. The number of fatigue striations observed wouldsuggest that the incorrect adjustment of the tie rod had occurredduring the period of major maintenance.