TRANSPORT ACCIDENT INVESTIGATION COMMISSION
TE KOMIHANA TIROTIRO AITUA WAKA

AIRCRAFT ACCIDENT REPORT

No. 89-016

RESURGAM Mk 1
ZK-YAL

Raetihi Airport
Raetihi

5 February 1989

Transport Accident Investigation Commission
Wellington · New Zealand

Price $11.70 (including G.S.T.)

ISSN 0112-6962

Transport Accident Investigation Commission
Wellington

Chief Commissioner
Transport Accident Investigation Commission

The attached report summarises the circumstances surrounding the accident involving Resurgam Mk 1 aircraft ZK-YAL at Raetihi Airport, Raetihi on 5 February 1989 and includes suggested findings.

This report is submitted pursuant to Section 8(2) of the Transport Accident Investigation Commission Act 1990 for the Commission to review the facts and endorse or amend the findings as to the contributing factors and causes of the accident.

4 December 1991

R CHIPPINDALE
Acting Chief Executive

APPROVED FOR RELEASE AS A PUBLIC DOCUMENT

9 December 1991

M F DUNPHY
Chief Commissioner

AIRCRAFT:	Resurgam Mk 1	**OPERATOR:**	Mr J.A. Lys
REGISTRATION:	ZK-YAL	**PILOT:**	Mr P.A. Webster
PLACE OF ACCIDENT:	Raetihi Airstrip, Raetihi	**OTHER CREW:**	Nil
ATE AND TIME:	5 February 1989, 1900 hours *	**PASSENGERS:**	Nil

SYNOPSIS:

The Office of Air Accidents Investigation was informed of this accident at 2030 hours on 5 February 1989. Mr R. Chippindale was Investigator in Charge and commenced the field investigation the following day. The aircraft was making an approach to the airstrip when it was observed to oscillate in pitch. The left wing failed and the aircraft dived into the ground, fatally injuring the pilot.

1.1 HISTORY OF THE FLIGHT:	1.2 INJURIES TO PERSONS:	1.3 DAMAGE TO AIRCRAFT:	1.4 OTHER DAMAGE
See page 4.	**Pilot:** Fatal	The aircraft was destroyed	Nil

1.5 PERSONNEL INFORMATION:

See page 4.

	Flight Times	
	Last 90 days	Total
All Types	Not Known	
On Type	Not Known	

1.6 AIRCRAFT INFORMATION:

See page 5.

1.7 METEOROLOGICAL INFORMATION:	1.8 AIDS TO NAVIGATION:	1.9 COMMUNICATIONS:
See page 6.	Not Applicable.	Not Applicable.

1.10 AERODROME: INFORMATION:	1.11 FLIGHT RECORDERS:	1.12 WRECKAGE AND IMPACT INFORMATION:
Not Applicable	Not Applicable.	See page 6.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION:	1.14 FIRE:	1.15 SURVIVAL ASPECTS:
Post mortem and toxicological investigations revealed no abnormalities which might have affected the pilot's ability to conduct the flight.	Fire did not occur	The severity of the impact rendered this accident unsurvivable.

1.16 TESTS AND RESEARCH:	1.17 ADDITIONAL INFORMATION:	1.18 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES:
See Page 7.	See page 9.	Nil

2. ANALYSIS:	3. FINDINGS:
See page 9.	See page 11.

4. SAFETY RECOMMENDATIONS:	5. APPENDICES:
See Page 11.	Nil

* All times in this report are NZDT (UTC + 13 hours)

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 The pilot, Mr Webster, was one of a number attending a microlight "fly in" at Raetihi Airstrip over the holiday weekend of 4 to 6 February 1989.

1.1.2 The aircraft, a Resurgam Mark 1, had been transported by road to the site, in a de-rigged state, on 3 February. Unsuitable weather precluded flying until late afternoon on 5 February.

1.1.3 Mr Webster assisted the owner with the aircraft's assembly and at about 1830 hours, the owner took the aircraft on a short flight consisting of two circuits of the airstrip.

1.1.4 On completion of this flight, Mr Webster arranged with the owner to take the aircraft for a flight, with the stated intention of flying only one circuit.

1.1.5 Witnesses who observed Mr Webster's take-off commented that he "took a long time to get off" and that the aircraft "porpoised" on take-off.

1.1.6 A circuit was flown but instead of landing as originally planned, Mr Webster overflew the strip at low level, at moderately high speed, in the landing direction. At that time there was another aircraft on approach and another preparing for take-off.

1.1.7 During Mr Webster's flight, the owner made the observation that Mr Webster was flying "too fast" and that he had not reduced the power setting from full throttle.

1.1.8 Mr Webster then flew a second circuit and as the aircraft made its final approach it flew into the lee of some trees to the left of the final approach path. Some turbulence had been encountered in this area on earlier flights.

1.1.9 The aircraft was observed to "porpoise" vigorously at least twice and the engine note was heard to rise and fall as if the throttle were being "gunned".

1.1.10 At the top of one of the aircraft's pitch oscillations, the wings were observed to flex noticeably downward. As positive loading was restored, the left wing failed upward, outboard of the strut attachment. The aircraft rolled sharply to the left and dived to the ground.

1.1.11 Personnel at the airstrip rushed to the scene of the accident but found that the pilot had received fatal injuries.

1.1.12 The accident occurred at approximately 1900 hours. The accident site was in a paddock on the opposite side of State Highway 4 from Raetihi Airstrip, at an elevation of 1840 feet amsl. National Grid Reference 082994 (NZMS 260 Sheet S20 "Ohakune") Latitude 39°23'36"S,longitude 175°18'12"E.

1.5 Personnel information

1.5.1 Paul Anthony Webster, 50, began flying microlight aeroplanes in January 1985, having acquired his own DS27 "Honcho", ZK-PAW. He was the holder of a Microlight Aircraft Association of New Zealand (MAANZ) Novice Pilot Certificate which authorised solo flight but not the carriage of passengers.

1.5.2 His logbook contained records only for the first 12 months of his flying career, further flights not having been logged. Flight time up to the last logbook entry made in December 1985, indicated a total flight experience of 33.8 hours, all pilot-in-command on a variety of microlight aircraft.

1.5.3 The "Honcho", flown by Mr Webster, was damaged in a landing accident on 20 April 1986 (Accident Brief 86-037) and was not repaired subsequently. It was not known to what extent he continued his microlight flying on other types, nor what recent experience he had.

1.5.4 He first flew ZK-YAL in August 1985, on a 15-minute sortie comprising 2 circuits. His logbook entry for the flight noted that the aircraft had "VERY SENSITIVE pitch control" (his capitals).

1.6 Aircraft information

1.6.1 Resurgam Mark 1, MAANZ number 322, was constructed by the owner using plans supplied by the designer, Gordon Bedson and Associates, Bundurra, New South Wales, Australia. The aircraft was registered ZK-YAL and was issued a Permit to Fly on 19 July 1985.

1.6.2 The Resurgam in its original state was a single-seat, high-winged monoplane powered by a König 3-cylinder 430 cc 18 kW (24 hp) engine driving a 3-bladed 1149 mm ($45^1/_4$ inch) diameter pusher propeller. It was designated as a Class 2 Microlight aircraft at the time of issue of the Permit to Fly.

1.6.3 The forward fuselage was wooden-framed, with a ply skin. The rear fuselage consisted of three longitudinal aluminium alloy tubes with diagonal bracing between them; to these were attached the fin, rudder and stabilator. The engine was mounted to the upper rear of the main fuselage, with the propeller's plane of rotation located between the top two rear fuselage tubes.

1.6.4 The detachable wings were of conventional design, with full-depth main and aileron spars. The main spar had top and bottom spruce spar caps and a plywood web. There were seven ply-reinforced foam ribs to each wing, numbered 1 to 7 from the wing root. Nose ribs of a lighter foam were aligned with these ribs, except for ribs 1 and 7 which were continuous, and supplemented by three additional nose ribs to each bay.

1.6.5 The wing skin forward of the main spar was 1 mm ply which, together with the main spar and a leading edge sub-spar, formed a torsion-box structure; the entire wing was fabric covered. Ailerons were mounted on each aileron spar between ribs 4 and 7.

1.6.6 At each wing root, attached to each side of the main spar by reinforcing structure, were two steel alloy plates corresponding to similar plates located on the centre section. Through these, chordwise holes accommodated wing attachment bolts. Wing locating fittings were located at the leading edge sub-spar and at 415 mm ahead of the trailing edge in a similar manner. A blade fitting on each aileron torque tube engaged a slot in the corresponding torque tube on the centre section when the wing was in position.

1.6.7 A tubular lift strut was attached to each wing at strut plates located on the spar, between ribs 3 and 4, and to strut attachments on the lower fuselage.

1.6.8 ZK-YAL was first flown by the owner on 30 August 1985. On 10 November 1985 the aircraft, flown by the owner, was ditched in Manukau Harbour (see Accident Brief 85-013). The aircraft suffered minor damage during the recovery from the tidal mudflats.

1.6.9 During the subsequent repairs, the owner refurbished the aircraft and made some modifications to the airframe. These included widening the centre section and aft fuselage to accommodate a larger engine/propeller installation and adding a 280 mm (11 inch) tip extension to each wing. Although wingtips were provided for in the original design, no drawings could be found for the centre section modification. The aircraft was first flown after its repairs in June 1987.

1.6.10 At some time between 5 September and 21 November 1987, a larger engine, a Konig 4-cylinder 570 cc 22.5 kW (30 hp) model was fitted, giving improved performance over the previous model. A larger diameter propeller was also fitted.

1.6.11 The last modification to be incorporated before the accident was the fairing of the joints in the aft fuselage tubes with foam, to reduce aerodynamic drag. After the penultimate flight, the owner reported that the aircraft handled "better than ever".

1.6.12 Up to the time of the accident, the aircraft had accrued some 40 hours flight time.

1.7 Meteorological information

1.7.1 The New Zealand Meteorological Service reported:

> "On 5 February a small depression moved quickly eastwards across the southern half of the North Island during the day. It is likely that there was some rain with low visibility and some patches of low cloud for much of the day but this should have cleared by late afternoon."

1.7.2 Witness reports of the conditions at Raetihi airstrip at the time of the accident indicated that the wind was westerly, between 5 and 15 knots. Cloud cover was reported as 7/8 at 3000 feet.

1.7.3 To the left of the final approach path was situated a belt of trees, in the lee of which other pilots, including the owner of ZK-YAL, had encountered turbulence. One pilot mentioned that he had struck "negative g" in this area.

1.7.4 The opinion of the Meteorological Service was that significant turbulence could be expected in the lee of the belt of trees in the circumstances described.

1.12 Wreckage and impact information

1.12.1 The aircraft impacted on a north-westerly heading in a nose-down attitude beyond the vertical, while rolling to the left. The top portion of the rudder was embedded in the grass surface on initial impact and was torn off as the aircraft rebounded. The main wreckage came to rest some four metres to the north-west of the initial ground strike.

1.12.2 The forward fuselage was fragmented, the largest significant portions being the right sidewall and the floor structure. The tubular rear fuselage had fractured aft of the centre section, but its control cables remained attached. It lay adjacent to the forward fuselage wreckage, with the fin, rudder and stabilator still in position.

1.12.3 The right wing, still connected to the centre section and with its strut attached, lay close to the wreckage of the fuselage. The left wing, from which the strut attachment had been torn along with a section of the main spar, lay outboard of the right wing. The left wing was completely detached from the centre section, the attachment bolt having torn through the attachment plates on the latter.

1.12.4 The left wing strut was still attached at its lower end to the fuselage fitting; its upper end was attached to the strut plate fitting and a portion of the main spar which had been broken out. The strut exhibited an acute-angled bend at about its mid point.

1.12.5 Pre-impact control integrity was established.

1.12.6 The engine with the propeller attached, was still in position on its bearers. Turf embedded between its two upper cylinders indicated an inverted impact and at least one propeller blade showed evidence of having dug some 200 mm into the ground.

1.12.7 The position of the throttle and the functioning of its cable and linkages were not established owing to the extensive disruption of the forward fuselage.

1.12.8 Strip examination of the engine revealed no defects which may have contributed to the accident.

1.16 Tests and research

1.16.1 The left wing spar attachment fitting and the strut, together with the right wing spar attachment fitting, were submitted to the Industrial Processing Division (IPD) of the Department of Scientific and Industrial Research (DSIR), Lower Hutt for detailed metallurgical examination.

1.16.2 The failed portion of the left wing was submitted to the Wood Technology Division of the Forest Research Institute, Rotorua for detailed examination.

WING SPAR ATTACHMENTS

1.16.3 The material of the wing spar attachment fittings complied with the designer's specification. It was a heat- treatable alloy in its softest condition. Proper heat treatment after fabrication could have doubled the yield strength of the material. However, the material in its "as supplied" form met the design criteria and had been specified because of its known properties.

LIFT STRUTS

1.16.4 The lift strut had failed in compression, the DSIR report stating, in part:

"The drawing specifies that 2024 T3 grade aluminium tubing of 1.25 inch (31.75mm) diameter and wall thickness 0.063 inch (1.6mm) is used. The thickness of the failed strut tube was measured to be 1.47 mm or 0.058 inch. The strut material was not '2024 T3', which has a yield strength of 345 MPa, but a material similar in composition to UNS A96101, a heat-treatable aluminium alloy which has a yield strength of 75-195 MPa. The hardness of the strut was 73 HV which corresponds to a yield strength of approximately 190 MPa, confirming that the alloy is similar to UNS A96101. The strength of this material is just over half (that) of the specified strut material and, in addition, the strength of the strut would have been further reduced as the wall thickness was less than that specified."

1.16.5 A newsletter from the designer to Resurgam builders, dated 1 November 1983, offered the following advice:

"In some cases alternative materials have been used successfully, thus alleviating the annoying problem of waiting for materials. A typical instance would be the use of Alcan 6063 T8 extruded tubing 32m (sic) dia x 1.6m (sic) thick for the lift struts. This has proved to be very satisfactory...it is very much cheaper than the 2024 tubing called for on the drawings."

1.16.6 Although the DSIR analysis noted similarity of the strut material to UNS 96101, it also met the specifications for UNS 96063 (i.e. Alcan 6063), the two alloys being very similar.

1.16.7 The owner indicated in a letter to the Australian Ultralight Federation (AUF) that he had in fact utilised the alternative strut material.

1.16.8 The AUF conducted a series of tests on the Resurgam Mk 2 wing in September 1987 and in June 1988. The Mk 2 wing was similar, but not identical, to the Mk 1 wing. During the 1987 tests, "After approximately half of the next set of loads had been added (starting at the wingtip), the port wing strut failed. The load at failure was equivalent to -1.9 g. The wing struts were made from commercial grade aluminium tube of size 32 mm OD by 1.6 mm wall thickness."

1.16.9 The 1988 report noted that "The wing struts were replaced. The new struts have a wall thickness of 3.0 mm ... (however it is still 'commercial' grade aluminium; the actual specification is to be notified)." The report also stated: "Any torsional movement of the wing causes a rearward bending in the strut (approximately 6 mm at -3.3 g)."

1.16.10 The widening of the centre section, by some 580 mm, effectively displaced the wings and therefore the strut attachment points outward. This necessitated replacing the struts, originally 1956 mm in length, with new struts of 2225 mm length between attachment bolt holes. These struts were not supported over this length by any intermediate or "jury" struts.

SPAR FAILURE AND WING CONSTRUCTION

1.16.11 The Forest Research Institute report indicated that the outboard spar fracture was consistent with an upward and rearward twisting motion of the outer portion of the wing. Sloping grain, with a gradient of 1:10, was noted in the area of the fracture in the upper spar cap, the slope exceeding the

recommended limit of 1:15. It was suggested however, that the measured density of the material compensated for any strength reduction due to grain slope.

1.16.12 The report also noted that seven consecutive nose ribs (riblets) were not glued to the plywood skin, as although the glue was in place on the skin, the riblets had been positioned to one side of the glue lines: also some of the riblets which had been correctly positioned with respect to glue lines had not been bonded adequately.

1.16.13 The seven unbonded nose riblets comprised number 3, i.e. the forward portion of rib 3, and the next six outboard from that position. This amounted to an approximate 1200 mm (4 ft) length of the torsion box structure. The riblets inboard of rib 3 were all found to have an unbonded area of about 150 mm in length on their lower surfaces. Although the light foam riblets had suffered considerable fragmentation on impact, the non-bonding was evident by the total absence of glue on the ply skin in the areas indicated.

1.16.14 Similar incomplete bonding was discovered on riblets 5b and 5c, and 6, 6a and 6b which were located, laterally, halfway off the glue lines on the lower edge. The intermediate riblets were lettered for the purpose of this report, 1a being for example, the first riblet outboard of rib number 1.

1.16.15 The Airworthiness section of the Air Transport Division of the Ministry of Transport indicated that the torsional stiffness and therefore the overall strength of the wing would have been severely compromised by the lack of bonding of the seven consecutive riblets.

1.17 Additional information

1.17.1 One of the witnesses, an experienced pilot and microlight instructor, estimated the downward deflection of the wings immediately prior to the failure to be in the order of 5°, the wings deflecting symmetrically. He also stated that he had observed an "opening up" at the point of attachment of the left wing to the centre section. Sitting in another microlight awaiting takeoff, he had a virtual head-on view of the approaching Resurgam and the accident sequence.

2. ANALYSIS

2.1 After assembly of the aircraft, with which the owner was assisted by Mr Webster and others, the owner took the aircraft for a short uneventful flight. On completion, the owner commented on the handling qualities of the aircraft following some streamlining modifications and allowed Mr Webster to take it for a flight.

2.2 Mr Webster had flown the aircraft before but it was not established what time on type or recent experience he had acquired.

2.3 When Mr Webster flew the aircraft, it became airborne after an apparently long takeoff roll, "porpoising" somewhat as he climbed out. His first circuit was followed not by the expected landing, but by a low run along the strip at "high speed". A second circuit was then flown. On final approach, in an area where the owner and other pilots had earlier experienced some

turbulence, the aircraft was observed to "porpoise vigorously", coincident with the rising and falling of the engine note. At no prior stage had the power setting been heard to reduce from maximum.

2.4 A possible explanation for the failure to throttle back followed by the low run was the jamming of the throttle control in the full open position; in that event, Mr Webster may have flown the low run and second circuit while he considered what action to take. However, no evidence was found to support this theory.

2.5 It was also possible that the pilot was indulging in a "beat-up" of the airstrip; certainly the impression of the speed attained by the aircraft would be consistent with this.

2.6 The porpoising motion of the aircraft could have been initiated by an encounter with the turbulence in the lee of the trees adjacent to the approach and sustained by Mr Webster's efforts to maintain pitch attitude, in other words a pilot-induced oscillation (PIO). Characteristically PIOs were generally divergent, i.e. each successive oscillation would be larger than the preceding one.

2.7 The observed pitch oscillations were sufficiently large to induce negative g at the top of each oscillation. The lift struts probably had sufficient flexibility to permit the observed downward flexing of the wings; a 5° deflection would have been sufficient to "unzip" the "Velcro" taped fairing strip which covered the 50 mm gap between the wing root and the centre section, giving the impression of "opening up".

2.8 The changes in engine note could also be explained by a momentary engine "cut" each time the float-type carburettor was subjected to negative g.

2.9 The effect of the unbonded riblets over a 1200 mm length of the torsion box structure would have been to permit greater than normal torsional movement of the outer half of the left wing. With the increasing angle of attack as the aircraft approached the bottom of the pitch oscillation, the centre of pressure would move forward. Given that the typical range of centre of pressure movement for this type of aerofoil was between 20 and 30% of chord (measured from the leading edge), and that the main spar was located at 30% chord, a "nose-up" pitching moment would have been applied to the wing. With the outer half having more torsional flexibility than the inner half, twisting of the wing would have resulted.

2.10 Twisting of the outer portion of the wing in the sense described, would have resulted in a further forward centre of pressure movement, further exacerbating the effect, and resulting in a torsional failure of the wing. (The phenomenon known as "divergence"). If, as the owner maintained, the aircraft was being operated at high speed, this would have increased the magnitude of the aerodynamic loads.

2.11 The damage sustained by the left wing attachment fittings, the failure of the strut and the inboard fracture of the main spar, occurred on impact, rather than in flight. For the wing attachment fittings to have failed in flight in the manner found, the left wing would need to have deflected downward in excess of 30°.

3. FINDINGS

3.1 The aircraft had a valid Permit to Fly at the time of the accident.

3.2 The pilot held a MAANZ Novice Pilot Certificate.

3.3 The pilot's total flight time and recent experience could not be established.

3.4 The pilot did not suffer from any pre-existing condition that could have resulted in in-flight incapacitation.

3.5 The reason for the pilot's deviation from his stated intention of flying only one circuit was not determined.

3.6 The aircraft's pitch excursions were probably the result of a pilot-induced oscillation initiated by turbulence.

3.7 The over-length lift struts had been fabricated from material of inadequate strength.

3.8 The owner had used the strut material in good faith, on the designer's advice.

3.9 Failure of the left wing occurred in the area outboard of the strut attachment plate during transition from negative to positive loading.

3.10 A constructional omission had compromised the wing's structural integrity in this area.

3.11 Operation at a speed excessive for the conditions may have been a contributing factor.

3.12 The probable cause of this accident was a pilot-induced oscillation in pitch, which, combined with a constructional defect, caused structural failure of the left wing.

4. SAFETY RECOMMENDATIONS

4.1 As the results of the Australian Ultralight Federation's wing tests were circulated to Resurgam owners in Australia and New Zealand, it was not considered necessary to make any additional recommendations.

5. REGULATORY

5.1 Pursuant to Section 14(5) of the Transport Accident Investigation Commission Act 1990 the legal personal representatives of the pilot in command were invited to avail themselves of the opportunities afforded to them thereunder.

5.2 As a result of representations received the report was amended and amplified to clarify some of the points raised.

5.3 The representations made to the undersigned are not to be taken as an admission of liability on the part of the parties concerned and their statements are without prejudice to their right to act in any way they may consider fit in any proceedings or action which may be based on the events to which this report refers.

9 December 1991

M F DUNPHY
Chief Commissioner