GLIDER ACCIDENT REPORT BGA NO: 36/04

Aircraft Manufacturer:	Schleicher
Model:	Ka 7
BGA Number:	3957
Fin Identifier:	HHL
Year of manufacture:	1959
Owner:	Lincolnshire Gliding Club
Place of Accident:	Strubby Airfield, Alford, Lincolnshire.
Date of Accident:	26 May 2004
Time of Accident:	12:10 hrs (local)

Synopsis

Following an apparently successful winch launch, the right wing of the glider suffered a complete structural failure, approximately one metre outboard of the wing root, whilst the glider was manoeuvring in roll. The investigation was unable to conclusively determine the cause of the failure as the condition of the wood comprising the structure, and the general condition of the glue joints, all indicated that the wing should have been capable of withstanding the design loading. However, two scenarios were considered that could not be dismissed as possible reasons for the wing failure. Notwithstanding this, subsequent to the accident the BGA issued a mandatory Aircraft Inspection (No.042/07/2004) requiring wing and elevator inspections of Ka7, and other similar gliders.

1.0 Factual Information

1.1 History of the Flight

Following completion of an annual inspection and structural repairs to fuselage steel tubing in the skid rubber compression spring area, resulting from a landing on rough ground, the pilot undertook a general handling test, which included basic aerobatic manoeuvres. Witnesses observed that the winch launch and subsequent manoeuvres appeared to be normal. On landing, the pilot reported that whilst the aircraft flew normally there was a flapping noise in the vicinity of the port wing. This was considered to emanate from a loose aileron inspection panel that was taped closed for the second flight, the pilot then being satisfied that the aircraft was fully serviceable.

On the flight following the handling test, the pilot arranged to take a student pilot flying and was overheard discussing with the student aerobatic manoeuvres that he intended to perform. The glider was launched by winch to a height of between 1,000 to 1,200 feet agl, where it cleared the launch area by executing a turn to the right. The glider was then seen to roll to the right and left, (Witnesses vary in their reports as to the initial direction of roll and through how many degrees the turn continued.) apparently performing look-out turns as required prior to commencing aerobatic manoeuvres. However, as the glider rolled to the left the right wing was seen to fail approximately one metre from the wing root and detach from the aircraft. The glider then entered a dive[1] before adopting a near vertical descent path, hitting the ground at high speed. The detached right wing fell to the ground some 200 metres to the south.

1.2 Injuries to Persons

Both pilots were fatally injured.

1.3 Damage to Aircraft

The glider was destroyed.

1.4 Other Damage

Limited damage to a standing crop of mature rape.

[1]Again, some witnesses have stated that the glider was in a stable but accelerating descent, some say it was spiralling. It is generally accepted however, that a glider with one wing detached would most likely enter a stable descent with the remaining wing uppermost.

1.5 Personnel Information

1.5.1 Pilot

Sex/age	Male, aged 55 years
Medical	Self certification signed by pilot on 28 January 2003 and countersigned by his General Practitioner on 12 March 2003, in accordance with BGA procedures
Licence	BGA Glider Pilot Licence FAI Silver C Certificate completed 24 July 1994
Instructors rating	Assistant Category Instructor rating issued 2 September 1995
Last check flight	17 March 2002
Total Flying Experience	497 hours.

1.5.2 Student

Sex/age	Female aged 63 years
Medical	None (not required, pre-solo pilot)
Licence	Student pilot
Total Flying Experience	11 hours

1.6 Aircraft Information

1.6.1 General

The Ka7 is a tandem seat glider of conventional wood and fabric construction. It has a fabric covered steel tube fuselage and forward swept high set cantilever wings. The single spar fabric covered wings are constructed from pine and plywood, with the plywood-covered leading edge forming the wing torsion box. The wings are fitted with paddle type airbrakes. The cantilever tailplane is of similar construction to the wings. Both the front and rear seats are equipped with four point seat harnesses fitted with Quick Release Fasteners (QRF).

The Ka7 involved in this accident was constructed in Germany in 1959 and imported into the UK from Sweden in 1993 by the Lincolnshire Gliding Club. Following the inspection undertaken when the glider was undergoing repairs to the forward fuselage, a BGA Inspector issued a BGA Certificate of Airworthiness (C of A), with an expiry date of 25 May 2005

1.6.2 Wing construction

The wing spar on the Ka7 glider is of a design common to this type of glider. There is an upper and lower spar boom of laminated pine separated by pine spacing pieces. These booms are at their thickest at the root end of the wing and becomes thinner along the span towards the wingtip. A skin of plywood is attached to the front and rear faces of the spar to give it rigidity and some torsional strength. Ribs of conventional construction are attached to the front and rear faces of the spar to give the wing its shape. A skin of plywood is wrapped around the leading edge ribs and is glued to the top and bottom surfaces of the spar and the ribs. This forward part of the wing, which is known as the D-box, gives the wing much of its torsional strength. The torsional load path of the D-box on the K-7 wing does not extend to the wing root, as the leading edge at the fuselage is co-incident with the rear cockpit. Internal structure reacts torsional loading between the main spar and the wing rear attachment to the fuselage from a point approximately one metre outboard of the wing root.

1.6.3 Elevator

In flight, the tailplane produces a downward force to counter the wing nose down pitching moment, and the aircraft centre of gravity which acts forward of the lift produced by the wings. Movement of the elevators alters the lift on the tailplane such that the pilot can control the pitch attitude, and hence speed, of the glider. A trim tab is attached by a hinge to the rear of the right elevator. The pilot can adjust the trim such that the aircraft can maintain the desired pitch attitude without him having to provide any input to the control column. Should the elevator control become disconnected, then the aircraft will adopt the trimmed attitude.

The elevators are deflected by an arm assembly attached to the No 1 ribs (see Figures 1 and 2). This control arm joins both halves of the elevator and contains a bearing, which is deflected fore and aft by the elevator push rod. Because the elevators are hinged at the front edge, and the bearing is below the hinge line, this gives deflection of the elevators up and down from a neutral point. The two joined elevators are constrained by the pitch control bracket on to the central pivot but they ‘float’ on the outer pivots.

1.6.4 Weight and Centre of Gravity

The weight and Centre of Gravity was within the glider’s operational limitations. The combined weight of the two pilots (approximately 345 lbs) was within the maximum limit of 374 lbs. The Centre of Gravity (CG) position limits for HHL were met if the weight of the

pilot in the front seat was between 144 and 214 lbs. At 185 lbs, the weight of the P1 (front seat) was within these limits. The passenger in the rear cockpit, who weighed 130lbs, was positioned close to the CG position and therefore, in common with most tandem seat gliders, did not significantly affect the balance of the glider.

1.7 Meteorological Information

At the time of the accident there was no significant weather, no low cloud and good visibility. A localised sea breeze had given rise to a light easterly wind.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

Not applicable.

1.10 Aerodrome Information

The airfield at Strubby is a large flat disused airfield dating from WW2, with no factors which were considered relevant to this accident.

1.11 Flight Recorders

None were carried or required to be carried.

1.12 Wreckage and impact information

1.12.1 Accident site

The glider crashed in a crop of mature rape, with the detached portion of the right wing landing 200 metres to the south of the main wreckage site. Ground marks and evidence from the main wreckage indicated that it sustained a high-speed impact with the ground and this had caused damage to the failed section of the wing which remained attached to the fuselage, masking many of the features of the original fractures. There was minimal impact damage to the right wing, suggesting that the impact speed was relatively low and that the wing had been cushioned by the standing crop. The wreckage was recovered to the AAIB at Farnborough where a detailed examination of the structure was carried out.

1.12.2 Detailed examination

The examination of the glider's structure was conducted by the AAIB together with an expert from the Timber Research and Development Agency (TRADA). Pre-impact damage to the glider was identified in several areas: the failure of the right wing approximately one metre outboard from the wing root; a small region of compressive damage in the right wing lower spar boom, in the region of the wing failure; disbonding of the leading edge plywood skin at the No 1 rib on the left elevator.

Although there was some evidence of glue failure, not considered to be of significance in the context of the wing failure, the materials used in the construction of the right wing were considered to be in good condition; moreover, the water content of the wood was below the 20% threshold considered to be necessary to support fungal decay. It was assessed by the TRADA expert from the general condition of the wood that the wing should have been capable of sustaining its design loading. The fracture areas of the wood were generally clean and all damage was judged to be consistent with the wing having been subject to a high positive load. Examination of the lower spar boom indicated that at some point it had sustained some compressive damage before failing in tensile overload, but when this occurred could not be established. The upper spar boom failed as a combination of high torsion and tensile loads, probably very shortly after the failure of the lower spar boom.

On the left hand elevator it was noted that where the plywood skin had come away from the No 1 rib; the surface of the exposed glue joint had little in the way of wood fibres adhering to it, indicating a poorly effected joint. Moreover, the surface of the glue was dull, indicating that the failure was relatively old (see Figure 2), possibly dating from the time of manufacture. A joint in such a condition was considered, in the opinion of the expert from TRADA, to have little or no capability to transmit torsional loads through the glue, as intended in its design.

1.13 Medical and Pathological Information

A post-mortem examination of the glider's occupants determined that they both died of multiple injuries sustained in the accident.

1.14 Fire

There was no fire.

1.15 Survival Aspects

This was not a survivable accident, and it is considered unlikely that a successful abandonment of the glider would have been possible, given its starting height following wing separation. Whilst only the P.2 was wearing a parachute (the P.1.had worn the only available parachute for the first 'test' flight, and had handed this to the P.2 for the second flight), both pilots would have been secured in their seats by four-point harnesses. The connecting lugs on the rear seat harness, which were still connected to the quick release buckle, sustained damage consistent with a rapid deceleration of the glider, whereas, the front seat harness connecting lugs were not engaged with their buckle and were virtually undamaged. There was, however, no further evidence from the wreckage examination that any attempt had been made to abandon the glider, as neither canopy had been unlatched.

1.16 Tests and Research

1.16.1 Speed stability

In order to gain some understanding of the speed characteristics of the Ka7 following a small control deflection in pitch, a series of test flights were flown and the attitude, time to achieve manoeuvre speed (Va) and time to the maximum test speed were recorded, see below. Va is defined as the speed below which the airframe will not sustain damage by the application of full control surface(s) deflection in one axis. However, structural damage may result if simultaneous large control inputs and/or large control deflection reversals are made below Va in more than one axis.

The starting position for each test point was 45 knot (IAS), with the glider in trim and with the stick 7.8 inches from the instrument panel, which equated to the elevator being in the neutral position.

Stick position (Inches forward of datum)	**Approximate attitude achieved** (Degrees nose down)	**Speed/max. test speed achieved** (knots (IAS))	**Time to speeds** (Sec)
0.5	10	57	20
1	25	74 (Va) 80	? 10
1.5	Continuous nose down pitch to 100 knots (IAS)	74 (Va) 100	5 7
2.5	Continuous nose down pitch to 100 knots (IAS)	74 (Va) 100	4 5

1.17 Organisational and Management Information

The BGA operate a maintenance system for gliders operating within their control. During the annual CoA renewal inspection, a BGA qualified Inspector certifies that all BGA mandatory inspections have been carried out and a record of this is required to be maintained in the front section of the glider's log book. By signing the appropriate form, BGA Form Insp. 267, an Inspector is certifying compliance with all relevant inspections for the glider type. Any that are repetitive, or that compliance cannot be verified, have to be carried out or repeated as necessary. If no record has been kept, then the Inspector completing the inspection must repeat all relevant inspections to be able to certify the BGA 267 form.

1.18 Additional Information

1.18.1 Mandatory Technote (TN18), Appendix 1

The accident database of the BGA and LBA (The German Airworthiness Authority) revealed that there had been at least two previous occurrences of failure of the bonding between the No. 1 elevator rib and the plywood skin forming the D-box at the root end of each elevator. On each occasion the glider was reported to be difficult or impossible to control in pitch. One glider reportedly landed, the other to have crashed. Consequently, Mandatory Technote 18 (TN18) was issued by the manufacturer, and mandated by the LBA as AD 72-7/3, requiring the elevators of the Ka7 family of gliders to be inspected every three years for signs of deterioration of the glue bond of the No1 rib of the elevators. TN18 specified that the fabric covering the joint on the elevator was to be removed prior to the inspection of the glue bond.

1.18.3 Embodiment of Mandatory Technote (TN18) on HHL

At the initial issue of the CoA, and at all subsequent renewals, the certifying Inspector concerned certified that all mandatory inspections had been carried out. Although this procedure does not require each inspection to be detailed separately, these certifications are, by implication, stating that the requirement of TN18 had been carried out at the appropriate times. However, it was not possible from the glider's documentation to establish when TN18 had last been carried out on HHL. The BGA inspector who carried out the inspection of the accident aircraft in preparation for the issue of the most recent C of A, clearly remembered checking the integrity of the elevator; however, this inspection was carried out without removing the fabric covering the elevator joint. When the inspection is carried out i.a.w. TN18, it is a requirement that the fabric strip applied after the previous inspection, is removed and then replaced after inspection of the joint.

1.19 Useful or Effective Investigation Techniques

None

2.0 Analysis

Analysis of the right wing failure indicated that the wing had been subject to an upward force sufficient to cause the lower spar boom to fail in tension, following which aerodynamic loads then caused the wing to twist and flex upwards. This resulted in the failure of the upper spar boom and the detachment of the wing from the aircraft. With the exception of the disbonded elevator skin, the glider was considered to be in relatively good structural condition with no evidence of fungal decay of the wooden structure or general deterioration of the glue that might have compromised the ability of the structure to withstand design loads. However, it is probable that the compressive damage discovered in the right wing lower spar boom was present prior to the failure of the wing and possible that this could have resulted from a heavy landing or the aircraft's recent excursion over rough ground that necessitated repairs to the steel tubing in the fuselage. Whilst the presence of such damage could reduce the wing's ability to withstand positive loading, the expert from TRADA felt that this was unlikely and that the wing should have been capable of sustaining its design loads. However, such a landing could possibly have encouraged the already poor quality glued joint at the No 1 rib position on the left elevator to weaken, although it almost certainly had not failed at that time as two successful winch launches were subsequently performed.

One scenario leading to the wing failure, based on a wing with no significant pre-existing damage, is as follows:

If the right wing was truly capable of sustaining its design loads just prior to the failure, then it must have experienced loading beyond its normal capability. For this to happen, the glider must have flown outside of its flight envelope, and the fact that only one wing failed would suggest that this occurred whilst manoeuvring, for example, whilst simultaneously rolling to the left and pitching nose up. Large amplitude control reversals whilst manoeuvring are also known to induce high stress within wing structures, to the extent that structural damage may occur below Va. The tests conducted in para. 1.16.1 indicated that, with an airworthy glider, the manoeuvre speed (Va) of 74 kts could easily be achieved in only some 4 seconds with a (reasonable) stick deflection of 2.5 inches. Although none of the witnesses stated that the glider pitched down and accelerated prior to the failure of the wing, with such a relatively slow glider it is possible such an acceleration may not have been very apparent or even noticed. Should the elevator glue connection at the No. 1 rib on the left elevator have failed after completion of the winch launch but not as a result of the accident, then difficulty, or loss of control in pitch, which is known to occur, could well have caused Va to have been unintentionally exceeded, or approached, possibly whilst the pilot was manoeuvring prior to conducting aerobatic manoeuvres. Thus the possibility that unintentional manoeuvring at or close to Va may have overstressed the wing could not be dismissed as a possible causal factor in the accident.

A further scenario, but based on a wing containing pre-existing damage, is as follows:

What was not established from the examination of the wing failure region, and the wing structure generally, was the actual integrity of the structure, the glue joints in particular, following the recent accident that damaged the glider's fuselage. Any upward acting forces applied to the fuselage sufficient to cause damage/deformation of the fuselage structure, would be reacted by the inertia of the fuselage and wings where, initially, a downward flexing of the wings would be induced. It is difficult to quantify the severity of such an event, but the presence of compression damage in the lower spar boom indicates that damage may well be caused by such events. In this situation, however, one would expect both wings to have been affected, unless the loading was only just sufficient to cause the relatively minor observed damage, and that inherent small differences between the strength of individual wings allowed

only one wing to sustain damage. Notwithstanding this, the presence of such damage in a wing declared as serviceable, raises questions as to the level of inspection that may be required following abnormal events such as heavy landings, landings on rough ground or load factor excedances in flight. The presence of such compression damage raises the possibility that other damage might have been induced, for example, in glued joints or parts of the wooden structural members in critical areas that, potentially, could have been masked by the large number of likely similar failures caused by the impact.

Just before the wing was observed to fail, the glider had performed a winch launch where, typically, the wing root bending moment may be approximately 2.5 to 3 times that experienced in 1g flight, and elevator torsional loads are likely to be at their highest should the pilot pull back on the control column towards the top of the launch. The torsional loads on the wing may actually reduce as, at the high angles of attack experienced during such a launch, the centre of lift will move forward towards the torsional axis of the wing. It may be argued in this scenario that, during these launches, progressive weakening of the right wing occurred which only manifest itself as the pilot subsequently manoeuvred the glider either normally, aggressively or possibly unintentionally, due to the failure of the glue joint in the left elevator, prior to commencing aerobatic manoeuvres.

Notwithstanding this, a winch launch, particularly at high weight, is structurally demanding and not thought to be consistent with a wing containing significant weakness surviving two such launches prior to the failure. Although this scenario is considered to be less likely than the one outlined above, the possibility that the wing contained a weakness brought about during its previous landing on rough ground, which progressively worsened during the two flights prior to the accident, could not be completely dismissed.

Should the wing have failed due to straightforward overload, brought about by manoeuvring close to or above Va, then it would seem prudent to recommend that the BGA remind pilots of the significance, in terms of structural loading, of single or multi-axis large control inputs and/or control reversals when flying close to or above Va.

However, should the wing have failed due to a progressively weakening of the wing, instigated by damage to its structural members and/or glue joints in critical areas following, for example a heavy landing, but precipitated by normal intentional (with the elevator rib joint intact) manoeuvring or unintentional manoeuvring brought about by failure of the glue joint at the No

1 rib, then questions are raised as to the level of inspection required of the wings following such events.

Safety action already taken

Following this accident, the BGA have issued a Mandatory Inspection (BGA No.042/07/2004, Appendix 2) requirement for the critical intrusive inspection, before next flight, of the aircraft generally and the wings in particular, of Ka7 and Ka7 conversions. Other gliders of a similar construction are required to undergo the same inspection, but with a more relaxed timescale. This inspection does not, however, automatically call for such intrusive inspections following landings which result in damage to the fuselage (typically around the wheel/skid areas).

In addition, the inspection of the elevator rib No 1 glued joint is now required to be carried out annually, instead of every three years, in accordance with the extant requirements of AD72-7/3 and the applicable Schleicher Technical Note 18.

Conclusions

The absence of any hard evidence that there was a pre-existing weakness in the right wing of HHL, coupled with the clear evidence of a very poor glue joint at rib No 1 on the left elevator, the failure of which is known from previous events to lead to difficulty in controlling the glider in pitch, suggests that the most likely reason for the failure of the wing on HHL was due to loss of pitch control, probably whilst manoeuvring the glider in roll. However, concern remains that following any landing that results in damage/deformation of the fuselage, that subtle damage may be caused within wing or tailplane structures that may not be apparent externally or subject to intrusive inspection before the glider is released to service.

4 Safety recommendations

4.1 As it is possible that the wing may have failed due to straightforward overload brought about by manoeuvring when close to or above Va, it is therefore considered prudent to make the following safety recommendation.

Safety recommendation No. 2005/01/BGA

It is recommended that the British Gliding Association remind glider pilots of the significance, in terms of structural loading, of single or multi-axis large control inputs, or control reversals, when flying close to or above manoeuvre speed, Va.

4.2 Since concern remains that, following any landing which results in damage/deformation of the fuselage, subtle damage may be caused within the wing or tailplane structures of the Ka7 and similar gliders, that may not be apparent from an external inspection, the following safety recommendation is made.

Safety recommendation No. 2005/02/BGA

It is recommended that the British Gliding Association consider, following accidents or incidents to Ka7 and similar gliders, where significant damage is caused to the fuselage from heavy landings or landings on rough ground, a requirement for an intrusive inspection of the wing structure to be carried out before the glider is released to service.

John Hoskins,
Senior Accident Investigator,
British Gliding Association ***17 October 2005***

Figure 1 Left elevator D box at Rib No. 1 position illustrating poor glue bond

Note: Photographs show tailplane/elevator root from below

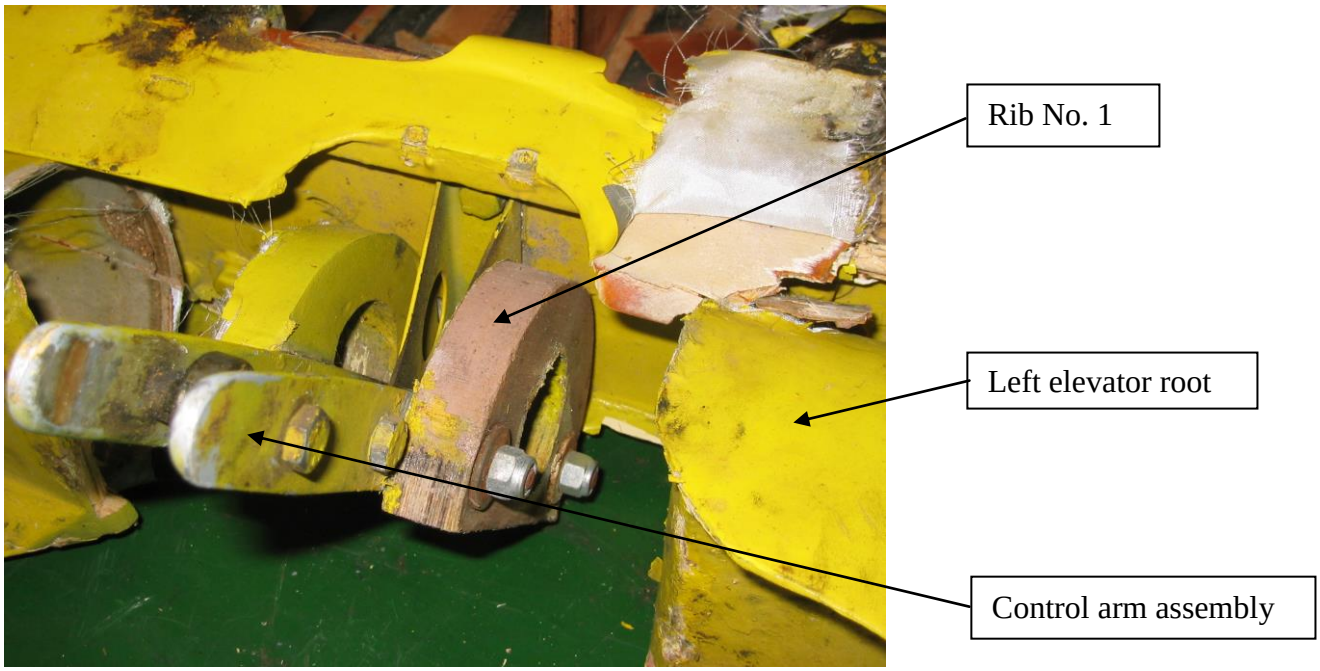

Figure 2 Left elevator Rib No 1 showing lack of wood fibre adhesion to the glue (pink surface). Note the failure of the wood skin in preference to the glue on the right elevator.