ACCIDENT

Aircraft Type and Registration:	Zenair CH601UL, G-YOXI
No & Type of Engines:	1 Rotax 912S piston engine
Year of Manufacture:	2005
Date & Time (UTC):	25 August 2006 at 1503 hrs
Location:	Near Bramley, South Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	Approx 220 hours (of which approx 40 were on type) Last 90 days - Not known Last 28 days - Not known
Information Source	AAIB Field Investigation

Synopsis

The pilot was performing a low flypast in his aircraft along a farm strip; it was not his intention to land there and he made no attempt to do so. There were power cables at the end of the strip and the aircraft pulled up and climbed over them. As it did so the main wing spar of the aircraft failed causing both wings to fold upwards. The aircraft crashed into a field and a severe fire started immediately. The pilot and his passenger were fatally injured in the accident.

History of the flight

The pilot had flown one local solo flight from Askern Farm Strip, South Yorkshire on the afternoon of 25 August 2006. On his return from that flight he met the owner of Askern strip (the passenger) and they agreed to fly over to Bramley to have a look at another farm strip that was under construction. The passenger had some weeks earlier met the person constructing the new strip and they had discussed together methods of preparing the surface and also a problem with some power lines crossing close to the northern end. The pilot had been involved in some of these discussions and he had offered to fly over the strip and view it from the air.

The passenger telephoned the owner of the strip to say they intended to fly over but he was out so he spoke instead to the owner's wife and explained to her that they intended to fly over to view the strip from the air. When the owner of the new strip returned home his wife explained to him that the aircraft was on its way. He was

concerned that the crew should be warned again about the wires and he tried to make contact both by telephone and by handheld radio on the helicopter frequency 122.95 Megahertz. He had previously discussed using this frequency with the visitors, but was unable to contact them. He then drove out to the north end of the strip and parked a small fuel bowser on a trailer, and his vehicle, underneath the wires to make their position obvious. He then stood by his vehicle and waited for the aircraft to arrive.

He saw the aircraft fly overhead at a height he estimated to be between 1,000 and 1,500 ft; it circled a number of times and then flew to the south. At about a mile from the south end of the strip he saw it turn to enter what he described as a steep descent, then level out and fly along the strip from south to north. He was surprised at the direction of flight as he noted that there was a wind of around 6 kt from the south, giving a tailwind. He saw the aircraft flying low along the strip with the wings level and he estimated it was at about 30 ft agl. As it came closer he started waving his arms in order to give warning of the wires. He then saw the aircraft start to climb at around 100 m from where he was standing and he ducked as it passed overhead. He turned and looked up at the wires which he expected would have been struck by the aircraft but noticed that they were intact and not moving. He then saw the aircraft wings fold upwards and parts of the aircraft break away before it descended steeply and crashed into an adjacent field. There was an immediate fire and he rushed into his house to get a fire extinguisher. He then drove down to the aircraft and attempted to tackle the fire but was unable to do so because of its intensity.

Witness information

A number of witnesses saw the aircraft around the time of the accident. They generally described it as being in a steep descent, before levelling out and then close to the ground starting to climb. Several witnesses saw the wings fold upwards as the aircraft climbed.

Pilot information

The pilot started flying in 2001 on flex-wing microlight aircraft. He qualified for his Private Pilot's Licence (Microlight) in August 2001 and over the next three years he accumulated some 150 hours of flight time. In 2004 he carried out a conversion to a fixed-wing microlight (of a different type from the accident aircraft) with a flying training organisation, and for a time he flew both flex and fixed-wing aircraft. The conversion training involved practical handling aspects of flying the aircraft; no groundschool training was included.

In May 2005 he purchased the kit for G-YOXI which he first flew in November 2005. Since then, although the details were not complete in the log books, he appears to have flown the aircraft at reasonably regular intervals and achieved a total some 40 to 50 hours flying in it.

On 8 June 2006 the pilot was sent a letter from the CAA regarding a complaint of low flying made about G-YOXI that had been reported by a member of the public, himself a qualified private pilot. The aircraft was reported to have been seen descending steeply and flying several times at a height of 150 to 200 ft across a small village with the wings 'waggling'. The reporter also noted that at the end of the low passes some steep turns were carried out. He reported that he was concerned for the safety of the aircraft as well as persons on the ground and pointed out that there were a number of power lines in the area.

Medical information

The pilot held a medical certificate countersigned by his general medical practitioner that was issued in

January 2001. At the time of issue the certificate was valid for a period of five years.

A post mortem examination was carried out on the pilot. There was no evidence of any pre-existing medical condition which could have influenced the accident.

Aircraft information

G-YOXI was a Zenair CH601UL, a derivative of the original CH600 Zodiac, and was of all-metal construction, predominately 6061-T6 aluminium. It was powered by a single Rotax 912S piston engine, driving a two-bladed composite propeller. The aircraft was fitted with two fuel tanks, one in each wing, and the fuel used was motor gasoline. The aircraft structural limitations were +4g and -2g. See Figure 1.

The aircraft had been acquired as a Quick Build Kit from Czech Aircraft Works in May 2005. This kit had been supplied with 51% of the structure, including the wings and fuselage, pre-constructed in the factory.

The Zenair Zodiac CH601L aircraft type has an airworthiness approval note issued by the PFA. The PFA had conducted flight tests on the aircraft type during which it was noted that the elevator control was 'light' and that

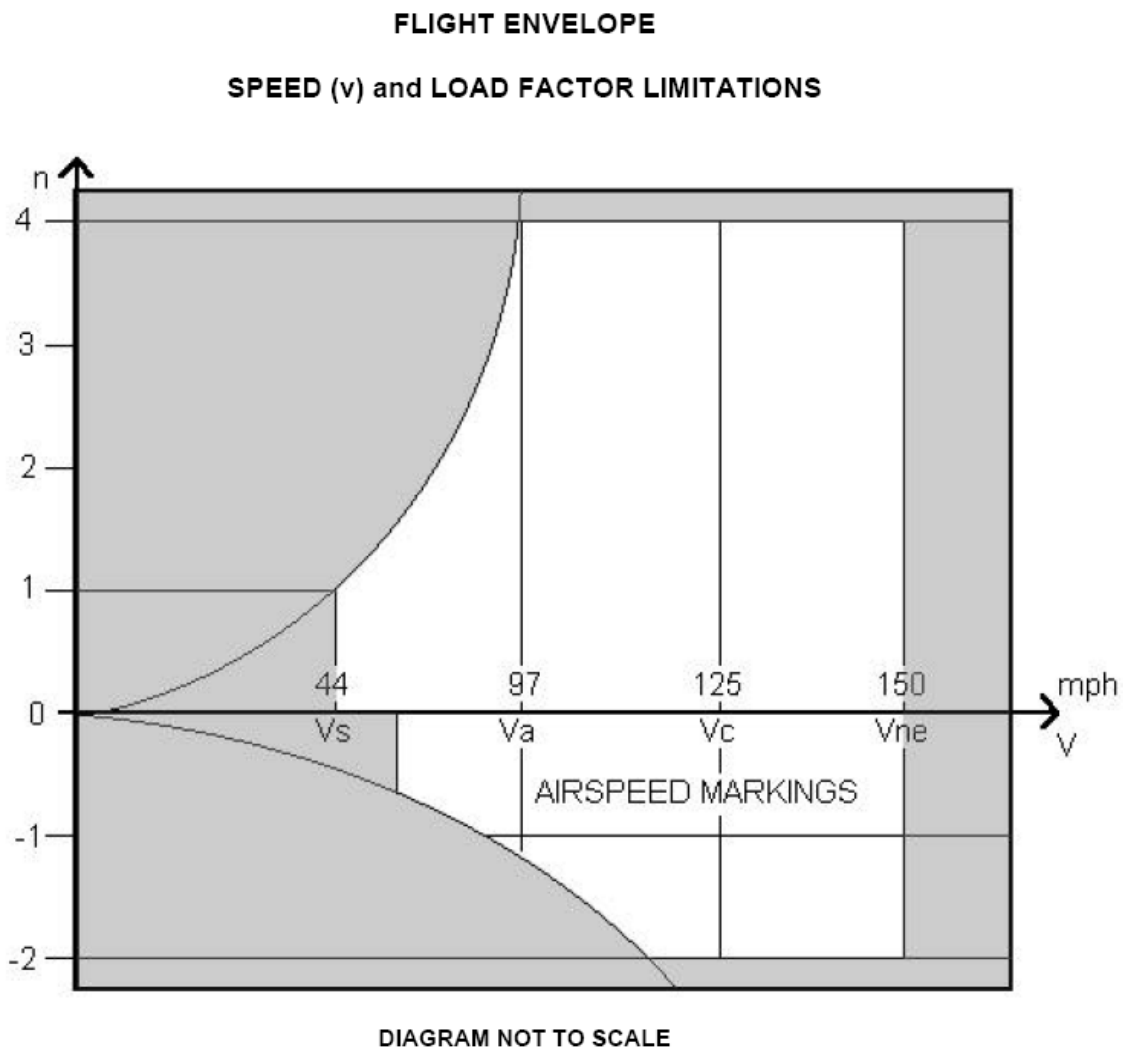

Figure 1

Load factor graph

there was a tendency towards pitch instability at higher airspeeds. As a result of this tendency a modification was introduced (MOD/162A/007) which restricted the aft CG limit to 17.5" (437.5 mm). To achieve this limit on G-YOXI it was a requirement that cushions were placed in front of the seat backs. The PFA provided the AAIB with a graph indicating the relationship of stick force to normal g for the aircraft. This shows that to achieve 4g a load of 9 daN (20 lbf) was required. The design requirements for the certification of very light aircraft are contained in CS-VLA, and paragraph 155 relates to the stick force per unit of g. The limit defined in CS-VLA 155 is that the stick force to achieve the positive limit load is not less than 7 daN (16 lbf). During flight tests of the aircraft the elevator control was described as 'very effective'.

The basic empty weight of the aircraft at the time of the certification flight test was 264 kg; the combined weight of the two occupants during the accident flight was around 160 kg. It was not possible to determine the amount of fuel on board at the time of the accident so, for the purpose of the investigation, it was assumed that a fuel load of at least 1/4 contents was available in each tank giving a total of 20 kg. The Maximum All Up Weight (MAUW) was 450 kg. This meant that at the time of the accident the aircraft was probably operating close to its MAUW.

Figure 2 shows a picture of an Airspeed Indicator (ASI) similar to that fitted to G-YOXI. The instrument is marked with colour banded airspeed ranges indicating the safe operating ranges and operating limits. The upper limit of the green band shows the maximum cruising speed for normal operation (V_{NO}), which in this case was the same as the manoeuvering speed (V_A) of 97 mph (see Figure 1). The V_A is the maximum speed at which the flight controls can be fully deflected without damage to the aircraft structure; it would not normally be indicated on an ASI. The yellow arc indicates the 'caution speed' range within which the aircraft should be operated only in smooth air. The red line is the never exceed speed (V_{NE}) and on this example is marked at 135 mph; however, the V_{NE} for G-YOXI was 150 mph, although it could not be determined what V_{NE} was actually marked on its ASI.

Wing structure

The CH601UL wing is a stressed skin cantilever design with the majority of the loads being carried by the front spar. The spar consists of three sections, each with additional upper and lower L section spar caps. The left and right front spars are attached to the centre front spar using two splice plates. For additional strength toward the centre of the wing, upper and lower spar cap doubler strips are added to the front of the spar. Wing ribs form the wing shape between the front and rear spars and are covered with a stressed skin. The rear spar consists of three z sections. The left and right rear spar sections each have an attachment plate through which a bolt attaches them to the centre rear spar. The entire wing structure is made from 6061-T6 aluminium.

Figure 2
Airspeed indicator

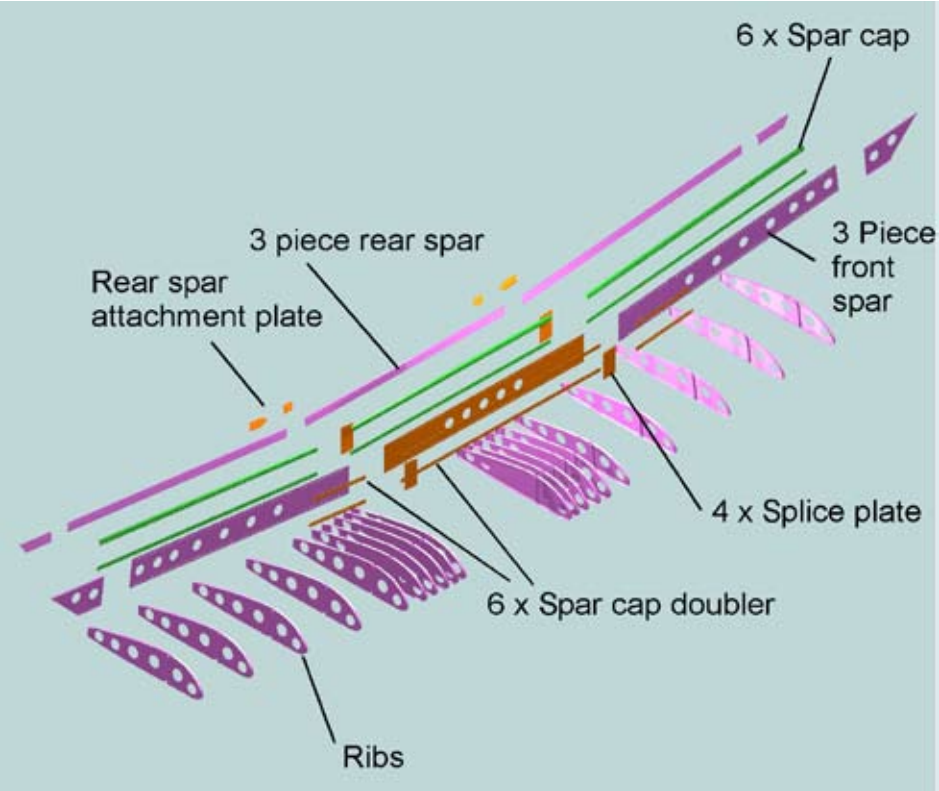

Figure 3

Wing Structure

Airstrip

The strip over which the aircraft flew was marked out with white edge marker posts and had recently been seeded with grass; it was 450 m in length. It was orientated in the direction 02/20 and sloped up in stages from south to north. At the northern end of the strip there was a helipad and nearby a sign on the ground indicting the presence of wires overhead. About 50 m from the north end across the extended centreline of Runway 02 was a line of three 11 Kva power cables at a height of 28 ft (4 m) agl. Beyond this the ground fell away again and there was an open field.

Accident site

The accident site was on a sloping field, which had recently been seeded with grass. The field was located to the north of the M18 Junction 1 and to the west of the carriageway. The aircraft had struck the ground some 330 m from the end of the strip on a heading of 020ºM. It initially hit the ground in a steep nose-down attitude, with the left wing low and at a relatively high speed. After the initial impact the aircraft bounced and travelled a further 20 m, inverting in the process before coming to rest. The left wing spar had remained attached to the centre spar. However the right wing front spar had become detached and the right wing was lying with its tip facing toward the direction of travel and on its leading edge. There was evidence of twisting of the right wing in relation to the fuselage and the left wing, as it remained upright whilst the remainder of the aircraft inverted.

The initial impact had caused the wing fuel tanks to rupture which led to a significant post-crash fire. The engine propeller was extensively damaged during the accident sequence, indicating that the engine was producing considerable power at impact. All the flying

controls were correctly connected and continuous; the elevator trim was at neutral.

Further south, toward the strip and about 100 m from the end of the strip, several pieces of Perspex and a GPS receiver were found. These indicate that the canopy had shattered whilst the aircraft was still in the air, ejecting the GPS receiver at the same time.

Since it was possible that the aircraft had struck the power cables, these were examined for signs of contact with the aircraft. Although there appeared to be some small notches on the cables none of these could be attributable to the accident. Indeed, had the aircraft caused the cable damage it would have resulted in the power lines shorting together and the electrical supply being isolated. At no point was the electricity supply along these cables interrupted.

Based on the accident site ground marks and the position of the Perspex on the ground, a basic trajectory model was produced. This shows that the aircraft needed to have reached at least 200 ft above the ground before the wing folded. Extrapolating backwards, this meant that the aircraft must have cleared the electricity cables with a large margin to reach this height. See Figure 4.

The forces imparted during the initial ground impact indicated that the accident was not survivable.

Examination of wreckage

The wreckage was recovered from the site and taken to the AAIB for further detailed examination. Examination of the wing revealed extensive damage to the wing front spar. Unfortunately, the post-crash fire had melted much of the aluminium including a large section of wing and the area of possible initial failure. Despite this, the shear webs of both the left and right front spars revealed buckling indicative of over stress in upload. Similarly, buckling of the upper spar caps also confirmed a compressive stress indicative of an upload. The centre front spar had signs of torsion on the remains of the upper and lower spar caps, which were probably a result of the left wing and centre section inverting whilst the right wing remained upright. This also indicates that although the spar had failed, allowing the wing to fold, it had remained attached to a certain extent at impact. Figure 5 shows a summary of the damage found to the wing front spar.

The rear spar attachment point between the left and right sections and the centre section showed evidence that the attaching bolts had pulled out from the attaching plates in a down and inboard manner. This was also indicative of an upload on the wing structure.

Metallurgy

The front spar was sent for detailed metallurgic

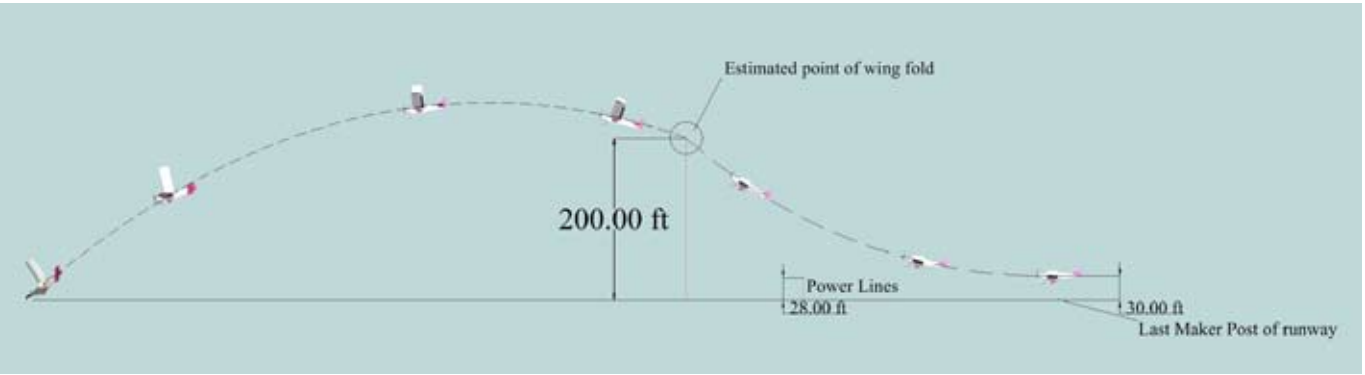

Figure 4

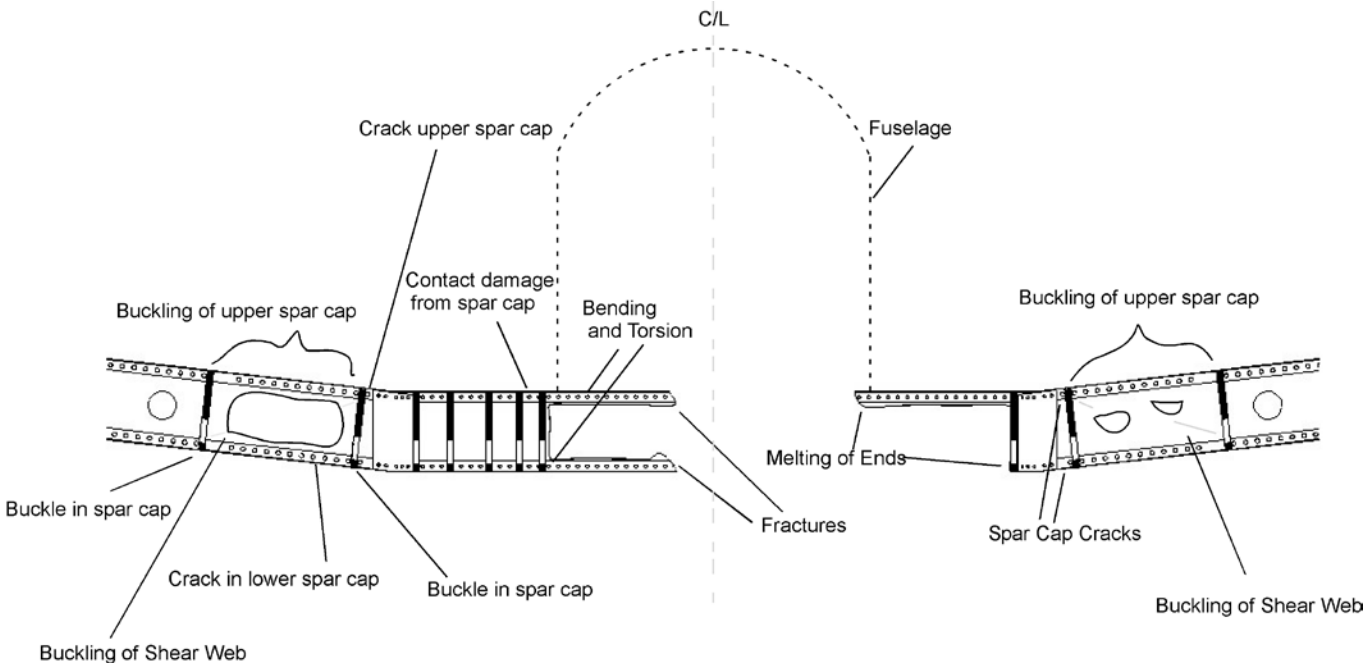

Figure 5

examination. This confirmed that the wing spar shear web, spar caps and doublers on all three sections of the front spar were constructed of 6061 aluminium. Unfortunately, due to the post-crash fire, it was not possible to ascertain if the heat treatment applied to the material at build was to the T6 specification. Examination of the fractures on the upper and lower spar caps of the centre spar section was inconclusive due to the damage of the surfaces caused by the post-crash fire, although the upper spar cap did show some topography suggestive of an overload failure.

Stress analysis

The CH601UL is designed to a limit stress of +4g and -2g so, with a normal safety factor of 1.5 incorporated, the ultimate load that the airframe can withstand would be +6g and -3g. The PFA provided the load analysis figures for the wing; one set were calculations by the aircraft manufacturer, the other set were those made by the PFA. Those calculations by the aircraft manufacturer declared either that the section being analysed was not critical or declared a margin of safety as a percentage at the ultimate load and at a higher MAUW of 480 kg. The PFA calculations were similar but declared a reserve factor, but these were for the CH600 rather than the CH601. The sections and the respective conclusions are shown in Figure 6 and Table 1.

The figure and table below reveal that the weakest point of the wing front spar is at the point at which the wing enters the fuselage, a similar position to that

Section	Aircraft Manufacturer Figures		PFA figures
	Shear	Bending	
A	Not Critical	Not Critical	N/A
B	Not Critical	Not Critical	N/A
C	Not Critical	Not Critical	N/A
D	Not Critical	Not Critical	1.7
E	11%	12%	1.6
F	Not Critical	2%	1.1

Table 1

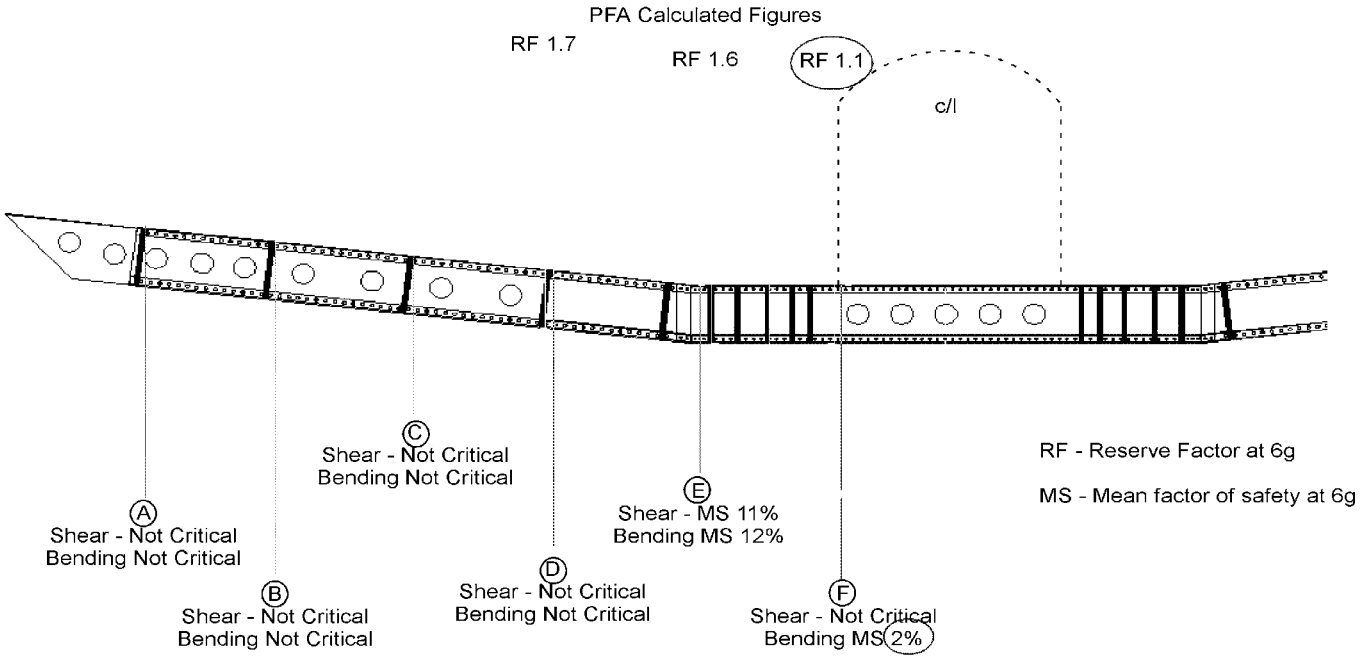

Figure 6

Aircraft manufacturer calculated figures

of the failure on G-YOXI. The aircraft manufacturer had conducted a destructive test to a similar wing on a CH600. The failure proved that the entire wing structure had a mean factor of safety of over 10% across the entire span.

Recorded information

A broken XDA II, which is a combination of a mobile phone and Personal Digital Assistant (PDA), memory card and associated Bluetooth Global Positioning System (GPS) receiver were recovered from the accident site. No useful data was recovered. Examination of radar data from Claxby radar head did not yield an aircraft track pertaining to the accident flight.

Analysis

The aircraft structure failed as a result of excess loads being applied; the breakage appears to have occurred at the most vulnerable point of the wing. The evidence is incomplete, but the aircraft was probably operating at, or close to, its weight and balance limits. The presence of the seat cushions in the wreckage suggests that they were probably in use, as required.

It could not be determined whether the structural failure was as a result of repeated overstress events, leading to a weakening of the structure, or whether a single event was responsible. In either case, the pull up at the end of the farm strip was the action that caused the eventual failure of the wing. It is not known whether the pilot pulled up as a result of seeing the wires only at the last minute, or whether he was always planning to pull up at the end of the strip.

On its approach to the strip from the south, the aircraft was seen in a steep descent prior to the low pass along the strip. This would have had two effects: firstly, the speed could have built up very rapidly, and secondly, to return to level flight for the pass along the strip, the pilot would have needed to pull up strongly, possibly applying

high g forces. This manoeuvre could have resulted in a weakening of the structure.

The aircraft had been observed flying at low level on one other occasion. Although flying at low level does not necessarily impose any greater than normal forces, it may lead to manoeuvres being carried out more abruptly than usual. Such manoeuvres may impose higher stresses on the airframe. It is possible, therefore, that the aircraft had been overstressed on a number of occasions and as a result the structure had been weakened.

It is not possible to know how much knowledge the pilot had gained in the course of his training and subsequent flying regarding manoeuvering speeds and the structural strength of his aircraft. The markings on the ASI should have given an indication of the safe operating ranges but their meaning may not have been well understood by him. The aircraft had sufficient power to exceed 97 mph in level flight so it is possible that the aircraft had flown on previous occasions at a cruise speed within the amber caution range and thus above the manoeuvering speed. Any turbulence or sudden manoeuvre would then generate high stresses on the airframe. Moreover, the aircraft exhibited low stick forces when the elevators were used in flight. As a result it would be relatively easy to apply excessive loads, particularly at higher speeds. Much of the pilot's previous training experience was on a flex-wing aircraft and the higher forces involved in flying this type of aircraft may have led him to a false perception of the stick force that could safely be applied when manoeuvring G-YOXI.