Rans S6-ESD, G-MYLA

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Aircraft Type and Registration:	Rans S6-ESD, G-MYLA
No & Type of Engines:	1 Rotax 503 piston engine
Year of Manufacture:	1993
Date & Time (UTC):	6 October 1999 at 1510 hrs
Location:	Monewden, Suffolk
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - 1 Fatal - Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	124 hours (of which 70 were on type)
	Last 90 days - 2 hours
	Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

History of the flight

The aircraft was based at Cherry Tree Farm, Monewden, which has a grass runway, about 800 metres long and orientated 220°(M). The field at the southern end of the runway was being ploughed and the deep, heavy clay furrows ran across the direction of take off. In this direction, the field is about 280 metres long and, at the time of the accident ploughing of about 250 metres nearest the runway had been completed.

Although there are hangars at the farm, G-MYLA was kept in the open. It was reported that the pilot used 4 star motor fuel into which he mixed Silkolene 2 oil. The jerrican of fuel found in the back of the pilot's car after the accident was full, so it is assumed that the fuel in the tank on the accident flight had probably been there since, at the latest, the last time it flew on 17 September 1999.

The AAIB was not aware of any witnesses who saw either the pilot's pre-flight preparation of the aircraft, or the take off. The evidence of witnesses who saw and/or heard the aircraft after take off suggests that it was climbing out normally and that there was nothing unusual about the sound of the engine up to the point where it stopped suddenly. The attention of a person working in an adjacent field was drawn to the aircraft when the engine noise stopped. He estimated that it was about 200 feet agl when it started to turn to the right, as if heading back towards the airfield, and lose height. The aircraft's nose then dipped suddenly and it descended rapidly to impact the ground in a steep nose down attitude.

The tractor ploughing the field had just turned and was now travelling from left to right across the take off track, when the driver saw the aircraft through the right window of the cab. It appeared to be climbing normally; he could not hear the engine because of the high ambient noise level in the cab. He lost sight of it temporarily but when it came into view through the open sunroof, it was about 150 to 200 feet agl. He noticed that the propeller had stopped and was lying horizontal. He lost sight of it again but when he looked back in the direction of the runway, he saw it had impacted the ground and was lying with the tail pointing upwards. He left the tractor and went immediately to the site. The pilot was half out of the left side of the aircraft and was bleeding from the head, nose and mouth; he remarked that there was a strong smell of fuel. He then went back to the tractor and drove to the farmhouse to get help.

One of the people who came to the site was a commercial pilot and, with help, he removed the pilot from the immediate vicinity of the aircraft. He checked for a pulse but was unable to detect one. He then returned to the aircraft and switched off the fuel and the magnetos. He noticed that the pilot's restraint harness had failed.

Meteorology

An aftercast from the Meteorological Office at Bracknell indicated that there was an anticyclone centred over the English Channel with a light north-westerly airstream over the area.

Surface wind 290°/6 kt

Visibility 25 Km

Cloud 2 oktas base 4,000 feet

Temp/Dew point +13°C/+4°C

QNH 1028 mb

Pilot's flying experience

The pilot started flying training on weight shift microlight aircraft in March 1989. A year later he was awarded a Private Pilot's Licence with a Microlight Aeroplane rating. His first flight in G-MYLA was in October 1993 when he had a total of 55 hours flying experience. In 1994 he flew about 30 hours and from then he flew less each year achieving only 7 hours in 1997, 5 hours in 1998 and 4:20 hours in 1999; his last flight prior to the day of the accident was on 17 September 1999.

Medical and pathology

Post mortem examination of the pilot revealed no pre-existing medical condition which could have contributed to the accident. The most severe injuries suffered by the pilot were to the head, with multiple fractures to the frontal bone with direct damage to the underlying brain. It was the pathologist's opinion that death was due to this injury.

The Medical Certificate for Microlight Aeroplanes, which was in his licence was dated 7 July 1994. This was 5 days before his 57th birthday and, for pilots between the age of 50 and 69 years, renewal is required annually. The Medical Centre where the examination was conducted had no record of any subsequent Certificate being issued.

The pilot had, apparently, been investigated for 'giddy spells' in 1998 but nothing abnormal was found. No other significant medical history was known.

Aircraft information

The aircraft type falls into the micro-light category. It is built from a kit and a number of engine types may be used. Generally known as the Coyote Mark 2, differences exist between aircraft bearing that name in the number and position of fuel tanks, features of the tail surfaces and in dimensions of flying surfaces.

The engine in G-MYLA was a twin cylinder, in-line, air cooled, two stroke used in a large number of aircraft types and capable of being mounted in either pusher or tractor configuration. A system of ducting on this type directs cooling air over the fins of the cylinders. The cooling air flow is created by a belt driven fan which, in this installation, draws air from the cowling area at the rear of the engine and passes it forwards. The fan belt tension is increased by removing shims, positioned between the two sides of a pulley thus narrowing the V shaped cross-section of the pulley and causing the belt to run further from the relevant pulley axis.

The engine is equipped with two thermocouples, one secured to each cylinder by the relevant sparking plug. These thermocouples are connected to a gauge on the pilot's instrument panel, providing cylinder-head temperature indications.

Accident site

The aircraft was found to have struck the surface of a ploughed field in a steep nose-down attitude on a heading close to that of the grass runway. The impact features were consistent with those normally resulting from a stall or spin. The engine was partly buried and the cabin area of the aircraft was largely destroyed. The ground evidence suggested that the propeller was not rotating at impact; failure of the propeller took the form of a simple rearward break of one blade.

Considerable fuel was present in the fuel tank and no defect was evident in the fuel system other than damage consistent with impact effects. Fuel flowed from the damaged area of one of the carburettors when the aircraft fuel valve was selected 'on'.

The pilot's lap-belt had failed in the stitched area where the tongue, which engages in the release box, is normally secured to its webbing. The tongue was still correctly engaged in the release box.

The aircraft structure and flying control system were examined in the field and no evidence of any pre-impact defect or failure was found. The aircraft was then salvaged and returned to the AAIB headquarters where further examination took place and the engine was removed.

Subsequent examination

Engine

The engine was subjected to a detailed strip examination. It was noted that the drive belt for the cooling fan was slack, imparting little or no torque to the fan. Further examination revealed that the belt was excessively worn on its bevelled working surfaces. The flat surface on the inside of the belt was reduced to about half its normal width, and the maximum width of the belt (ie of that surface visible on the outside of the installed belt) was reduced from 10 mm to approximately 8.2 mm. Both belt pulleys were found to be extensively corroded. It is known that roughness of the working surfaces of the pulleys, resulting from corrosion, causes rapid wear of the cooling fan belt.

The internal examination of the engine revealed that extensive overheating had occurred over a significant period of time. Burnt oil adhered to the inside of the pistons and had produced a glazing effect on the cylinder walls. All four piston rings were seized in their grooves in the pistons. The heat effects were most noticeable on the piston at the power-take off end (ie the front in this installation). Considerable combustion gas 'blow by' had occurred and there was evidence of slight burning of the piston crown. This piston showed unmistakable evidence of having seized within the cylinder; the seized area remained clean. Generally similar effects were noted on the other piston and cylinder, although the heating effects were less extreme and seizure had not occurred.

Fuel

The fuel remaining in the carburettors had the characteristic smell of fuel which had been standing in a ventilated place for an extended period. Analysis confirmed that the Motor Octane Number (MON) was 81.6, significantly below the specification figure for 4 star motor fuel (ie leaded or lead replacement fuel). The specification BS 4040, which applied to the standard leaded 4 star motor fuel widely available at the time this fuel is believed to have been purchased, calls for a minimum MON of 86. The fuel had, however, a high lead content of 0.2 g/l compared with a maximum of 0.15 g/l specified in BS 4040 and the distillation and vapour pressure results did not indicate that a significant loss of the 'light ends' had occurred. The composition of the fuel does not therefore explain the low MON recorded.

The amount of 2-stroke oil was approximately 2.5% to 3.0 % and was consistent with Silkolene Comp 2. Although the percentage is higher than the 2% specified, it is unlikely to have been high enough to significantly affect the MON and would have had no detrimental effect on lubricity. (Its only detrimental effect on operation would have been to increase the risk of plug-fouling at low power settings).

Engine ancillaries

The ignition systems and the plugs were found to operate correctly and no defects were found in either of the carburettors. No pre-impact defects were found in the reduction gear or any other parts of the engine.

The condition of the cylinder-head thermo-couples indicates that the cylinder-head temperature gauge was almost certainly not working during the flight.

Seat harness

The pilot's seat harness was of lap and diagonal shoulder strap configuration (Figure 1). The shoulder strap was constructed from two pieces of webbing joined by an adjuster. The upper element was anchored outboard on the upper fuselage side. The lower element passed through a metal attachment bracket close to the aircraft centre line before transitioning to become the inboard section of the lap strap. The webbing was stitched to form a loop where it passed through the centre-line bracket. The stitching was arranged so that the lap-strap exited the bracket orientated in such a way that it formed an included angle of approximately 30 degrees with the alignment of the diagonal strap. The free end of the lap strap in this lower webbing assembly was secured by a stitched joint to the metal tongue fitting. The outboard section of the lap strap, fitted with the release box incorporating an adjuster, was anchored to the lower fuselage side.

Examination of the pilot's seat harness confirmed that failure had occurred in the stitching of the webbing securing the lap-strap to the metal tongue (Figure 1A). The end of the webbing in the failed area was passed through the slot in the metal tongue, then reversed through 180 degrees and further folded through 180 degrees, before being stitched through all three layers in a 'box and gate' pattern. The condition of the webbing assembly forming the inboard lap strap/diagonal strap, where it passed through the centre line attachment bracket, indicated that a far more concentrated loading had occurred at that point (Figure 1B) than had occurred at either of the other two end fittings ie the upper diagonal or the other lap strap to fuselage fitting.

It was noted that both harnesses were identical (ie not handed) and each was constructed in such a way that, at the point where the webbing joined the tongue, the reversed overlapping webbing section was stitched to the face of the parent webbing such that it was unavoidably in contact with the occupant's body in one seat position, whilst it was orientated away from the occupant's body in the other seat position. As assembled in G-MYLA it was in contact with the body in the pilot's position whilst away from the body of any occupant in the passenger position.

Thus, instead of a smooth webbing surface restraining the pilot, a joggle or step was present close to the tongue. Microscopic examination revealed that a hard object had abraded the inner (occupant) face of the webbing of the inboard lap strap and this abrasion extended to a point which would have been beneath the folded back, stitched area (Figure 2).

Discussion

The engine failure was the result of seizure of the piston in the forward cylinder. The eye witness evidence of a stationary propeller, the lack of any indication of rotation in the ground markings and on the propeller are all consistent with the total loss of power. During the strip examination there was an absence of internal evidence of a component failure, or any defect which could have led to loss of combustion pressure in the cylinders. However, it is known that this type of engine can experience seizure under certain adverse circumstances but then be capable of running freely once the engine cools down and operation with correct cooling begins. The clean condition of the seizure markings on the piston, however, indicate that no running took place after the evidence of seizure was inflicted. Hence, the seizure must have occurred at the end of the final period of operation of the engine, ie as the propeller came to a halt during the climb, seconds before the impact.

The piston seizure was probably brought about as a result of overheating, from the effect of blow by brought about by the absence of effective piston ring sealing (ie the effect of the seized rings), together with the loss of nearly all cooling as a result of the slack fan-belt. It is known that rapid belt wear results if the engine is operated with corroded running surfaces on the pulleys, as observed on this engine.

The increased damage in the front cylinder was probably the result of earlier operation, when some belt slip and loss of cooling began to occur. Under these circumstances, the cylinder further from the fan would run hotter since, with reduced air flow rate, the effect of pre-heating of the air, which passes the rear cylinder on its way to the front cylinder, would be much greater. A sustained period of operation during which overheating was regularly occurring, at least in the climb, probably led to progressive seizure of the rings in all the piston grooves, which then allowed blow-by and even greater overheating of the pistons to occur. Although the blow-by would have reduced engine performance, the effect in the climb was probably not very noticeable since:-

(1) at high RPM the percentage of charge mass lost past the pistons would have been lower than at cruise and descent engine speeds and

(2) the high power normally absorbed by the cooling fan at climb RPM could not have been transmitted to the fan and hence would have been available as additional shaft horsepower.

The MON of the fuel taken from the aircraft tank was significantly below that of either 4 star or lead replacement fuel. Operation at climb power with a low octane rating may have further contributed to overheating and increased the likelihood of seizure. Although a long period of ventilated storage can result in evaporative loss of the light-end components of the fuel and lead to a lowering of the MON, there was no evidence that this mechanism had occurred and the reason for the low MON could not be determined.

The condition of the cylinder-head temperature thermocouples and hence the non-operation of the temperature gauge appears to have been a fairly long standing condition. It seems likely that overheating of the cylinders during the climb on a number of previous flights may have occurred without being evident to the pilot. Cumulative damage must have occurred over a significant number of flights.

The evidence of witnesses who saw and/or heard the aircraft after take off suggests that it was climbing out normally and that there was nothing unusual about the sound of the engine up to the point where it stopped suddenly. The descriptions of the aircraft's behaviour from that point suggest that the speed decayed, possibly as the pilot attempted to clear the ploughed area and hedge. The right turn may have been a consequence of this rather than a deliberate turn back towards the airfield. The aircraft wing then stalled and it had entered the initial phase of auto-rotation when it hit the ground. The limited experience of the pilot, but more particularly his low level of recency would not have placed him in a good position to cope well with the effect of sudden power loss in the initial climb.

The pilot died from a serious head injury, which would not have occurred had the seat harness not failed. As he had no other life threatening injuries, it is possible that a helmet would have saved his life.

The features of the failure of the harness were consistent with the effect of a hard object cutting into the stitched area where the webbing joined the metal tongue, which engaged in the release box (Figure 2). This both loaded the right hand lap-strap of the harness excessively and forced apart the stitching securing the tongue. The orientation of the local stitched portion of the webbing was such that the hard object must have been interposed between the pilot's body and the inner face of the harness.

The hard object was almost certainly part of the pilots clothing; it was most probably a trouser-belt buckle. The concentration of loading of the pilot's harness at the aircraft centreline attachment, appeared to be the result of the sudden change in direction and increase in magnitude of loading of the webbing assembly at this point, after the failure of the lap strap. Once the lap strap failed, the bracket, which normally carried the load of the two strap sections lying at approximately 30 degrees to one another, rotated to align with the direction of the single remaining load of the diagonal strap. This caused the webbing to slide to one end of the slot in the attachment bracket and concentrated all loading on one side of the webbing rather than distributing it across the width of the material, as it does when the bracket is lying at its normal angle with both straps of the webbing assembly sharing the load. The condition of the webbing at this attachment point was thus consistent with the effect of the failure under load of the stitching adjacent to the tongue.

Unfortunately, the pilot's clothing was not retained or fully documented by the mortuary service and, although normal post fatality police photography was carried out on the pilot's body at the accident site, the pictures did not show the lower garments sufficiently clearly to enable the object causing the harness damage to be identified.

Another accident to a similar aircraft was investigated by the AAIB shortly before the accident to G-MYLA. The impact in the earlier accident appeared to be similar in nature and severity and the damage inflicted to the forward part of the aircraft was nearly as great and of generally similar distribution to that inflicted on G-MYLA. The pilot involved in that earlier accident survived, however, albeit with serious multiple injuries. In the case of the earlier aircraft, the harness did not fail and it was noted that the area of stitched webbing securing the tongue was orientated differently, ie on the side of the harness facing away from the occupant's body.

Conclusions

The aircraft was climbing out normally when one of the pistons seized and the engine stopped. The engine seizure was the result of a number of flights having been carried out with inadequate engine cooling. This inadequate cooling was the result of a badly worn fan-belt, which in turn was the result of a period of operation with corroded pulley surfaces.

The descriptions of the aircraft's behaviour after the engine stopped suggest that the speed decayed, possibly as the pilot attempted to clear the ploughed area and hedge. The right turn may have been a consequence of this rather than a deliberate turn back towards the airfield. The aircraft wing then stalled and it had entered the initial phase of autorotation when it hit the ground.

The pilot's harness failed and he died from a serious head injury which would almost certainly not have occurred had the seat belt not failed. As he had no other life threatening injuries, it is also possible that a helmet would have saved his life. The seat harness failed as a result of a hard object, probably a belt buckle or part of the pilot's clothing, cutting into the stitching of the webbing where the tongue was attached. This was made possible by the orientation of the stitched portion of the webbing, which secured the tongue and leads to the following recommendation.

Recommendation No 2000-61

It is recommended that when surveying aircraft or approving the installation of safety restraint harnesses, the CAA and PFA surveyors/inspectors should check the connections between the harness webbing and the metal components (release boxes, tongues and adjusters), where the latter are capable of being positioned against the occupant's body, to determine the safe orientation of reversed overlapped and stitched sections of webbing.