Statens haverikommission
Swedish Accident Investigation Authority





Final report RL 2021:04e

Accident North of Örebro Airport, Örebro County, on 22 August 2020 involving the powered sailplane SE-UYA of the model Arcus M, operated by Örebro Soaring Club.

File no. L-66/20

13 April 2021

SHK investigates accidents and incidents from a safety perspective. Its investigations are aimed at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigations do not deal with issues of guilt, blame or liability for damages.

The report is also available on SHK´s web site: www.havkom.se

ISSN 1400-5719

This document is a translation of the original Swedish report. In case of discrepancies between this translation and the Swedish original text, the Swedish text shall prevail in the interpretation of the report.

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Content

General observations

The Swedish Accident Investigation Authority (Statens haverikommission – SHK) is a state authority with the task of investigating accidents and incidents with the aim of improving safety. SHK accident investigations are intended to clarify, as far as possible, the sequence of events and their causes, as well as damages and other consequences. The results of an investigation shall provide the basis for decisions aiming at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigation shall also provide a basis for assessment of the performance of rescue services and, when appropriate, for improvements to these rescue services.

SHK accident investigations thus aim at answering three questions: *What happened? Why did it happen? How can a similar event be avoided in the future?*

SHK does not have any supervisory role and its investigations do not deal with issues of guilt, blame or liability for damages. Therefore, accidents and incidents are neither investigated nor described in the report from any such perspective. These issues are, when appropriate, dealt with by judicial authorities or e.g. by insurance companies.

The task of SHK also does not include investigating how persons affected by an accident or incident have been cared for by hospital services, once an emergency operation has been concluded. Measures in support of such individuals by the social services, for example in the form of post crisis management, also are not the subject of the investigation.

Investigations of aviation incidents are governed mainly by Regulation (EU) No 996/2010 on the investigation and prevention of accidents and incidents in civil aviation and by the Accident Investigation Act (1990:712). The investigation is carried out in accordance with Annex 13 of the Chicago Convention.

The investigation

SHK was informed on 22 August 2020 that an accident involving a powered sailplane with the registration SE-UYA had occurred north of Örebro Airport, Örebro County, the same day at 12:00 hrs.

The accident has been investigated by SHK, represented by John Ahlberk, Chairperson, Sakari Havbrandt, Investigator in Charge, and Tony Arvidsson, Technical Investigator.

Dietmar Nehmsch has participated as accredited representative of the German Federal Bureau of Aircraft Accident Investigation Bundesstelle für Flugunfalluntersuchung (BFU).

Hannu Melaranta has participated as adviser for the European Union Aviation Safety Agency (EASA).

Magnus Axelsson has participated as adviser for the Swedish Transport Agency.

The following organisations have been notified: BFU, EASA, the European Commission and the Swedish Transport Agency.

Investigation material

Technical examinations have been conducted of the accident site and in SHK's premises following recovery of the wreckage.

Interviews have been conducted with the instructor and the student.

Weather data have been obtained from SMHI and the tower at Örebro Airport.

Pictures of the sequence of events captured by a private individual have been obtained.

SHK has conducted a reference flight using an aircraft of the same type.

A fact finding presentation meeting with the interested parties was held on 7 December 2020. At the meeting SHK presented the facts discovered during the investigation, available at that time.

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Aircraft:	
Registration, type	SE-UYA, Arcus
Model	Arcus M
Class, airworthiness	Normal, Certificate of Airworthiness and valid Airworthiness Review Certificate (ARC)[1]
Serial number	38
Owner	Örebro Soaring Club
Time of occurrence	2020-08-22 at 12:00 in daylight Note: All times are given in Swedish daylight saving time (UTC[2] + 2 hours)
Location	North of Örebro Airport, Örebro County, (position 5914N 01503 E, 53 metres above mean sea level)
Type of flight	Trial lesson
Weather	According to SMHI's analysis: wind south-westerly wind 10–15 knots, visibility >10 km, cloud 2–4/8 with ceiling at 3 500–4 000 feet, temperature/dewpoint +23/+14°C, QNH[3] 1005 hPa
Persons on board:	2
Crew members	2
Personal injuries	The student was seriously injured
Damage to the aircraft	Substantially damaged
Other damage	None
The instructor:	
Age, licence	53 years old, LAPL (S)[4]
Total flying hours	195 hours, of which 39 hours on type
Flying hours previous 90 days	16 hours, of which 15 hours on type
Number of landings previous 90 days	10, of which 6 on type
The student:	
Age, licence	43 years old, 10 hours soaring, nothing in the past 23 years

[1] ARC – Airworthiness Review Certificate.
[2] UTC – Coordinated Universal Time.
[3] QNH – altimeter set so that the altitude above mean sea level is obtained when on the ground.
[4] LAPL – Light Aircraft Pilot Licence (Sailplane) – sailplane licence applicable within the EU.

SUMMARY

The purpose of the flight was to conduct an introductory flight. Following a short flight that passed normally, the instructor began the approach.

At an altitude of 70 metres, when the aircraft was on the final approach, with flaps in the landing position, the instructor felt turbulence; at which point the aircraft banked to the left. When he attempted to correct this with right rudder and aileron, the aircraft began turning to the left, which he was not able to prevent.

After the aircraft had turned 90 degrees, the instructor increased the rate of turn in order to avoid a patch of woodland that was in the direction of travel.

After turning 270 degrees, the aircraft hit the ground nose first, then yawed an additional 90 degrees before sliding backwards into the woods.

The instructor was able to climb out of the aircraft without assistance. The student broke his left foot.

Upon closer examination of the rudder mechanism, it was established that there had been contact between the right bolt for the rudder cable attachment and a fairing on the fuselage.

SHK has conducted a reference flight using an aircraft of the same type. At a normal final approach speed, 110 km/h, and with landing flaps extended, the aircraft was banked 15 degrees to the left and the rudder was kept at the potential obstructed position. Right aileron was then given in order to return to normal flight. This resulted in the aircraft's heading changing 45 degrees to the left.

It has not been possible to definitively establish the cause of the accident. However, it could be probable that rudder deflection to the right was obstructed by the bolt for the rudder cable catching on the edge of the fairing for the rudder cable and becoming stuck, which would explain the sequence of events.

Safety recommendations

The EASA is recommended to:

- Take action to ensure that the checklists for daily inspection and inspection following a hard landing are supplemented so as to allow any play or too small clearance between the rudder cable bolts and the fairings to be detected. *(RL 2021:04 R1)*

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 Sequence of events

The purpose of the flight was to conduct an introductory flight. Following a short flight that passed normally, the instructor began the approach.

At an altitude of 70 metres, when the aircraft was on the final approach, with flaps in the landing position, the instructor felt turbulence, at which point the aircraft banked to the left. When he attempted to correct this with right rudder and aileron, the aircraft began turning to the left, which he was not able to prevent. He retracted the airbrakes and set the flaps at position 2.

After the aircraft had turned 90 degrees, the instructor increased the rate of turn in order to avoid a patch of woodland that was in the direction of travel.

After turning 270 degrees, the aircraft hit the ground nose first, then yawed an additional 90 degrees before sliding backwards into the woods.

The instructor was able to climb out of the aircraft without assistance. The student broke his left foot and remained seated in the front seat until he was helped out by the rescue service.

The pictures in Figures 1–4 were taken from the intended landing site.

The student felt that the problems began when the airbrakes were extended.

The accident occurred at position 5914N 01503E, 53 metres above mean sea level.

Figure 1. Photo Per Nilsson.


Figure 2. Photo Per Nilsson.


Figure 3. Photo Per Nilsson.


Figure 4. Photo Per Nilsson.

1.2 Injuries to persons

	Crew members	Passengers	Total on board	Others
Fatal	-	-	0	-
Serious	1	-	1	-
Minor	-	-	0	Not applicable
None	1	-	1	Not applicable
Total	2	0	2	-

1.3 Damage to the aircraft

Substantial damage occurred to the fuselage, tail fin, stabiliser, flaps and ailerons.

1.4 Other damage

None.

1.4.1 Environmental impact

None.

1.5 Personnel information

1.5.1 Qualifications and duty time of the pilots

The instructor

The instructor, was 53 years old and had a valid LAPL (S) with flight operational and medical eligibility.

Flying hours				
Latest	24 hours	7 days	90 days	Total
All types	1	1	16	194
On type	0	0	15	39

Number of landings, on type – last 90 days: 6.
Type rating concluded in 2018.
Latest refresher training concluded on 13 June 2020 on ASK-21.

The student

The student, 43 years old, 10 hours soaring, nothing in the past 23 years.

1.6 Aircraft information

The powered sailplane has two seats and is built primarily from composite materials. The aircraft model has combined ailerons and flaps along the entire trailing edge of the wings.

The aircraft has a retractable engine, but this was not used during the flight.

1.6.1 The motorglider

TC-holder	Schempp-Hirth Flugzeugbau GmbH
Model	Arcus M
Serial number	38
Year of manufacture	2012
Gross mass (kg)	Max. 800 actual 740
Centre of gravity	Within limits
Total operating time (hours)	1,138

The aircraft had a Certificate of Airworthiness and a valid ARC.

1.6.2 The rudder system

The aircraft’s tail wheel is integrated into the rudder, which means that the lower hinge of the rudder also absorbs the forces that act on the tail wheel during take-off and landing.

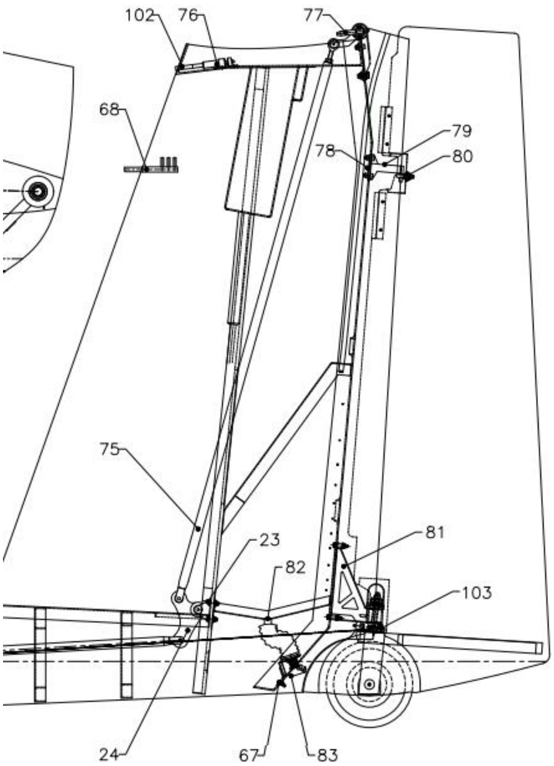

Figure 5. Source: Schempp-Hirth Flugzeugbau GmbH.

The aircraft’s checklists for daily inspection and inspection following a hard landing do not contain any specific points concerning inspection of the combined rudder and tail wheel system.

The instructions for annual inspection in the aircraft’s maintenance manual specify that the rudder is to be removed and the bracket is to be checked.

1.7 Meteorological information

According to SMHI's analysis: south-westerly wind 10–15 knots, visibility >10 km, cloud 2–4/8 with ceiling at 3 500–4 000 feet, temperature/dew point +23/+14°C, QNH 1005 hPa.

According to recordings from the tower at Örebro Airport, the wind direction at the time was 220 degrees, with gusts of up to 22 knots.

1.8 Aids to navigation

Not pertinent.

1.9 Communications

Not pertinent.

1.10 Aerodrome information

The airport had status in accordance with AIP[5] Sweden.

The plan was to land on grass runway 19, which is located just to the east of the airport's main runway (see Figure 6).

It is well known among those who have experience of flying from the area that turbulence can occur on the final approach to grass runway 19 when there is a south-westerly wind because the approach crosses a depression in the terrain.

1.11 Flight recorders

The aircraft had a GPS recorder on board. However, the recorder was set to make recordings at eight-second intervals. The last recording was at an altitude of 70 metres and in a position with a heading straight towards the runway.

1.12 Accident site and aircraft wreckage

1.12.1 Accident site

The aircraft crashed into a field of stubble before sliding backwards into the edge of a wooded area (see Figure 6).

[5] AIP – Aeronautical Information Publication.

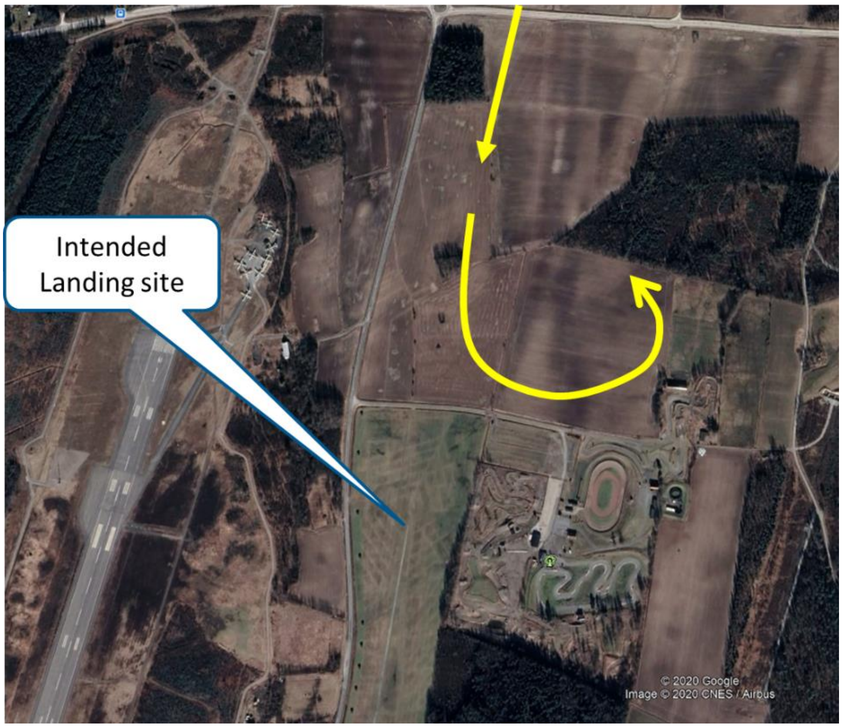

Figure 6. The yellow arrow shows the route to the site of the crash. Markings incerted by SHK. Photo: Google Earth. Map data © Lantmäteriet.

1.12.2 *Aircraft wreckage*

The nose of the aircraft forward of the front control stick was crushed but was still attached to the fuselage. However, the rescue service cut off part of the nose in conjunction with the rescue operation.

The tail section was broken off at the rear of the engine compartment and in front of the fin and the stabiliser had detached from the top of the fin. The part of the rudder above the tail wheel was detached and was lying by the side of the wreck.

The leading edges of the wings were completely intact.

Figure 7. Rudder in two parts. The lower part remained attached to the wreck following the accident.

1.13 Medical and pathological information

There is nothing to indicate that the mental and physical condition of the instructor was impaired before or during the flight.

1.14 Fire

No fire broke out.

1.15 Survival aspects

1.15.1 Rescue operation

SOS Alarm was informed of the accident by an eyewitness. People from the flying club reached the wreck within a few minutes.

The rescue service got to the site quickly and assisted in freeing the student through actions such as cutting away the control stick and the structure around the nose. The student was taken to hospital in an ambulance.

1.15.2 Position of and injuries to crew and passengers, and the use of seat belts

The injured student sat in the front seat and the uninjured instructor sat in the back seat. Both of those on board were strapped in using four-point harnesses.

1.15.3 Crash safety

The aircraft model is built in accordance with the CS-22 certification standard, which includes requirements concerning crash safety. The principle is for the cockpit around the pilots to be a strong cage and for the space for the legs to be used as a deformation zone.

1.16 Tests and research

1.16.1 Technical examination of the wreck

An initial technical examination was conducted at the accident site before the aircraft was disassembled and recovered. Ailerons, flaps and airbrakes were functioning normally.

The elevator control rod was broken at the level of the rupture of the tail section and the stabiliser had broken loose from the tail fin. All the indications were that the damage occurred upon impact.

The rudder cables were intact and it was possible to move the rudder pedals and actuate the rudder cables. Given that the upper section of the rudder was broken off, the remaining part, with the tail wheel, became movable both horizontally and vertically. A gap, upwards/downwards, of about 2 millimetres was noted.

Upon closer examination of the rudder mechanism, it was established that there had been contact between the right bolt for the rudder cable attachment and a fairing on the fuselage.

Figure 8. The picture on the left shows a bow-shaped track of wear on the inside of the fairing. The picture on the top right shows the lower rudder hinge. The picture on the bottom right shows the fairing from below.

The examination showed that it was possible for the rudder yoke to end up in a position in which rudder deflection to the right was completely obstructed as a result of the lower part of the bolt becoming hooked on the fairing.

The shaft of the lower hinge, which consists of an M8 bolt, was bent. It was also possible to tighten this one and a half turns before the join became rigid and gap-free.

The design is such that if the M8 bolt is firmly tightened, the yoke cannot move, but if the nut for the bolt becomes a bit loose, the yoke is able to move in a rolling motion (see Figure 9).

Figure 9. The picture shows the top of the hinge shaft, which consists of an M8 bolt. The rudder is attached to the yoke using the four M6 bolts, two of which are marked in red.

The rudder bell crank was reattached using a new straight bolt. The clearance between the rudder cable bolt and the fairing was measured at 3 millimetres.

A new attachment and rudder yoke were mounted on the wreck. The clearance was measured at 7 millimetres.

When the nut for the hinge bolt was loosened one and a half turns, the rudder cable bolt was able to make contact with the fairing.

Figure 10. The M8 bolt loosened one and a half turns with a new attachment and rudder yoke mounted.

1.16.2 Reference flight

SHK has conducted a reference flight using an aircraft of the same type in order to see how potential obstruction of the rudder affects flight characteristics and the potential to control the aircraft with an obstructed rudder.

The position of a potential contact between right rudder cable bolt and the fairing, deflected to the right by a degree or so, was marked with a piece of tape that was visible from the cockpit.

At a normal final approach speed, 110 km/h, and with landing flaps extended, the aircraft was banked 15 degrees to the left and the rudder was kept at the mark. Right aileron was then given in order to return to normal flight. This resulted in the aircraft's heading changing 45 degrees to the left before the wings of the aircraft were level, at the same time as a sharp sideslip from the right occurred. After having banked to the right for a moment, it was possible to resume to level flight without sideslip and the change to the heading was then almost 90 degrees to the left.

1.17 Organisational and management information

Not pertinent.

1.18 Additional information

1.18.1 Measurement and inspection of two other aircraft

SHK has asked two other owners of the aircraft model to measure the clearance between the rudder cable bolts and the fairing. The results were 4.5 and 5 millimetres, respectively. On one of the aircrafts, a bent hinge shaft was discovered in conjunction with the measurement.

On the other aircraft, after the rudder had been removed, it was noted that it was possible for the rudder bell crank to move freely in a rolling motion such that the bolts were able to come into contact with the fairings (see Figure 11).

Figure 11. The rudder yoke on another aircraft of the same type. Photo: Thomas Jobs.

The type certificate holder has stated that there have been incidences of bent hinge shafts on other aircraft following hard landings.

1.18.2 Previous repair of the rudder

In 2013, when the aircraft was still registered in Germany, a minor accident involving the aircraft took place. In this accident, the upper part of the rudder delaminated above the lower hinge.

According to the documentation that was prepared when the aircraft was registered in Sweden, a new rudder was installed at the time of the repair.

A new rudder was installed in May 2013, but in January 2014 the old repaired rudder was reinstalled. It has been confirmed that the rudder involved in the accident 2020 was the original rudder from the production of the glider.

However, SHK has received a copy of the repair record from the person who repaired and installed the rudder and this shows that it was the old rudder that had been repaired. The record shows that a correct amount of fibreglass has been used to repair the rudder.

1.18.3 Maintenance performed

The most recent annual inspection was performed by a company in Germany. There is a detailed record of the inspection of the engine, but for the other parts there is only a comment ‘annual inspection performed’. The maintenance organization has stated that they do not have any further documentation and that they believe they have implemented all of the measures stipulated in the maintenance manual.

1.19 Special methods of investigation

None.

2. ANALYSIS

2.1.1 Potential blocking of the rudder

The tracks shown in Figure 8 indicate that there has been contact between the right bolt for the rudder cable and the fairing the cable runs inside of. It is not possible with any certainty to exclude the possibility that these tracks have occurred during the crash. However, it is probable that at least the bow-shaped track has emerged over time, which would mean that – at least intermittently – there has not been any clearance between the bolt and the lower part of the fairing.

The hinge shaft was found bent on the wreck. It is not possible with any certainty to exclude the possibility that the bending occurred or got worse during the impact. However, the fact that a bent bolt was found during the SHK inspection of another serviceable glider, of the same model, suggest that it is possible that the hinge shaft was bent prior the flight.

As a result of the investigation it is possible to conclude that the hinge shaft was also bent on other aircraft of the same type. A shaft that is bent can result in the lower part of the rudder, with the tail wheel and the yoke for the rudder cables, being tilted. If this tilt is assumed to be one degree (1°), the bolt for the rudder cables will end up one and a half millimetres lower, which can result in an obstruction. A potential counter argument is that the upper part of the rudder counteracts such a tilt. However, the upper part of the rudder has relatively long flexible sides that would probably be able to take on a small deformation without much resistance.

If the bolt is bent such that the bolt is lowered by one and a half millimetres, the upper rudder only needs to be deformed by a millimetre on either side because it is closer to the hinge shaft in order for it to be possible for contact between the rudder cable and the fairing to occur. Consequently, the shell on the left must be compromised by one millimetre and the right elongated by one millimetre, which is not judged to require a large force (see Figure 12).

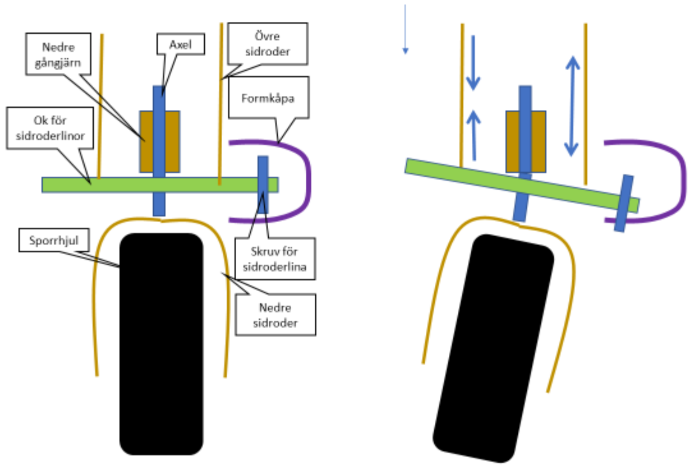

Figure 12. A sketch of the structure of the rudder, seen from the rear, and the consequences of a bent hinge shaft.

On one of the aircrafts on which SHK conducted control measurements, it proved to be possible for the yoke to move freely in a rolling motion when the rudder had been removed.

In this case as well, it is only the composite parts of the rudder that are preventing a movement that allows contact between the bolt for the rudder cable and the fairing to occur.

2.1.2 Effect of a potential obstruction

SHK's reference flight shows that, in the event of an obstruction of the rudder, it is not possible to maintain heading, under the prevailing conditions, if the aircraft suffers a roll disturbance to the left.

The reason why the aircraft yaws to the left when right aileron is given without right rudder being given simultaneously is aileron drag. When right aileron is given, the left aileron is lowered, which results in the lift, and thus also the aerodynamic drag, on the left wing increasing. The right aileron goes up, which reduces the lift and the drag on the right wing. Increased drag on the left wing and reduced drag on the right wing result in a yaw to the left. In normal circumstances, this is counteracted through a combination of aileron and rudder deflection.

2.1.3 Possible sequence of events

Provided that the rudder is obstructed from deflecting to the right, the following sequence of events is possible.

During the final approach, at an altitude of 70 metres, the aircraft suffered a roll disturbance to the left. The pilot corrected using right aileron but the rudder was blocked in a position with only a few degrees of deflection to the right. As a result of the aileron drag, the nose yawed to the left at the same time as a strong sideslip from the right arose. After a yaw of 45 degrees, the pilot made the assessment that it was not possible to reach the runway, which is why he instead pursued and even increased the rate of turn in order to avoid obstacles. When he had turned 270 degrees, the bank was relatively steep, the altitude low and the airspeed low. An attempt in this situation to exit the turn only using right aileron led to the aircraft sideslipping again and stalling[6] to the left.

The fact that the leading edges of the wings are undamaged, combined with the flight state in Figure 4, suggests that a stall and spin movement took place because only the nose made contact with the ground during the primary impact.

It is not out of the question that there was damage to the rudder system following previous hard landings that had not been detected during daily inspections.

[6] Stalling – the angle between the wing and the airflow became so large that the airflow was not able to follow the upper surface of the wing, resulting in a reduction in lift.

2.1.4 *Alternative sequence of events*

An alternative sequence of events is that the instructor temporarily lost control due to turbulence, which led to a deviation in heading, and then regained control.

Even if such a sequence of events is not totally out of the question, SHK makes the assessment that the statements from those on board do not support this sequence of events.

2.1.5 *The design of the rudder*

Combining the landing gear function with the primary control system, which is the case in the design in question, can entail risks. For example, hard landings can result in damage to the control system. The fact that bent shafts in the lower rudder hinge have been detected support this theory.

The manufacturer has compensated for this by stipulating in the maintenance manual that the lower rudder hinge has to be disassembled and inspected in conjunction with annual inspections of the aircraft.

However, the checklists for daily inspection and inspection following a hard landing do not contain any specific points concerning inspection of the lower rudder hinge.

In the event that daily inspection is performed with the aircraft standing on the tail wheel, it is not possible to detect any axial play in the rudder because the rudder is loaded upwards. In addition, the rudder will then be in the upper position so that the clearance between the bolts and the fairings becomes as large as possible. In flight, because of gravity, the rudder will end up in its lower position, which may reduce the clearance.

For this reason, SHK is of the opinion that it is essential for the tail section to be lifted so that the rudder is hanging freely, without a load on the tail wheel when the rudder is being inspected during daily inspection.

2.1.6 *Repair of the rudder following previous accident*

The aircraft has passed eight annual inspections since the repair was conducted in 2013, which gives reason to presume that the repair has not had an impact on the occurrence.

2.1.7 *Crash safety*

The fact that the injuries were limited to a broken foot, despite the fact that the full force of the relatively hard impact was taken up by only the nose of the aircraft, suggests that the structure of the cockpit has functioned in the intended manner.

3. CONCLUSIONS

3.1 Findings

a) The pilot was qualified to perform the flight.

b) The powered sailplane had a valid Certificate of Airworthiness and a valid ARC.

c) There is evidence that may indicate that the rudder has been obstructed.

d) Blocking of the rudder was possible.

e) Hard landings can have a direct impact on the primary control system of this aircraft model.

f) Information about specific inspection of the tail wheel and rudder system is missing from the checklists for daily inspection and inspection following hard landings.

g) It has not been possible to definitively establish the cause of the accident.

h) The injuries were limited to a broken foot.

i) The structure of the cockpit has functioned in the intended manner with respect to crash safety.

3.2 Causes

It has not been possible to definitively establish the cause of the accident. However, it could be probable that rudder deflection to the right was blocked by the bolt for the rudder cable catching on the edge of the fairing for the rudder cable and becoming stuck, which would explain the sequence of events.

4. SAFETY RECOMMENDATIONS

The EASA is recommended to:

- Take action to ensure that the checklists for daily inspection and inspection following a hard landing are supplemented so as to allow any play or too small clearance between the rudder cable bolts and the fairings to be detected. *(RL 2021:04 R1)*

The Swedish Accident Investigation Authority respectfully requests to receive, **by 13 July 2021 at the latest,** information regarding measures taken in response to the safety recommendations included in this report.

On behalf of the Swedish Accident Investigation Authority,

John Ahlberk Sakari Havbrandt