DUTCH
SAFETY BOARD

Crashed during winch launch

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N.B.: This report is published in the English and Dutch language. If there is a difference in interpretation between the Dutch and English texts, the English text will prevail.

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SUMMARY

On 29 June 2022, the Rolladen-Schneider LS1-d, a single seater glider with registration D-2057, took off from Terlet glider airfield by the winch launch method. The glider immediately made a steep climb after becoming airborne. At a height of approximately 20 metres, the glider made a slight roll movement to the right followed by a left hand turn with a steep bank angle. The glider then attained a nose-down attitude, started to rotate counter clockwise and crashed into the ground. The pilot was fatally injured and the glider was destroyed.

The Dutch Safety Board conducted an investigation into the possible cause of this accident. This investigation answers the question of what caused the glider to crash during the winch launch.

The technical investigation of the wreckage has not revealed, insofar as this was still possible due to the damage of the glider, any technical defects in the flight controls that could have played a role in the accident. The slight roll movement of the glider to the right was the first indication of a stall.[1] The pilot's response to this resulted in the left hand nose down turn with a steep bank angle. That moment, the glider had entered a stall condition. The stall arose because the critical angle of attack had been exceeded, which was initiated by a high rotation rate in the beginning of the winch launch. The pilot was not able to recover from the stall at low height.

A stall at low height during a winch launch is very critical, as a recovery from it is most likely impossible. This risk must therefore be anticipated and prevented. So, it is vital that procedures are followed strictly during the winch launch. The advice to avoid a stall during rotation is therefore to maintain a shallow climb after takeoff until adequate speed is seen with continued acceleration. Ensure that the transition from level flight at takeoff to the full climb (typically 35°) is controlled, progressive, and lasts at least 5 seconds.[2]

Gliding clubs regularly pay attention to the safe execution of the winch launch method during the training of a glider pilot. This also happens during the day-to-day operation of gliding clubs. The Dutch Safety Board therefore does not consider it necessary to make a recommendation regarding this subject. Nevertheless, with the publication of this report, the Board once again highlights the risks of the winch launch method, in particular the stall during rotation, with the aim of raising awareness of the risks. The importance of being aware of these risks does not only apply to student pilots, but also to experienced pilots.

1 The stall is a breakdown of the smooth airflow over the wing into a turbulent one, resulting in a decrease in lift. The lift will no longer fully support the glider's weight, and the glider sinks. The stall occurs when the critical angle of attack is exceeded.

2 British Gliding Association, *Safety Briefing, Safe Winch Launching*, January 2021.

ABBREVIATIONS

BFU	German Federal Bureau of Aircraft Accident Investigation
BGA	British Gliding Association
EASA	European Union Aviation Safety Agency
EU	European Union
ICAO	International Civil Aviation Organization
KNMI	Royal Netherlands Meteorological Institute
KNVvL	Royal Netherlands Aeronautical Association
LAPL(S)	Light Aircraft Pilot Licence (Sailplane)
LOC-I	Loss of control in-flight
UTC	Coordinated Universal Time

GENERAL OVERVIEW

Identification number:	2022079
Classification:	Accident
Date, time of occurrence:	29 June 2022, 14.57 hours[3]
Location of occurrence:	Terlet glider airfield
Registration:	D-2057
Aircraft type:	Rolladen-Schneider LS1-d
Aircraft category:	Glider
Type of flight:	Non-commercial - pleasure
Phase of operation:	Winch launch
Damage to aircraft:	Destroyed
Flight crew:	One
Passengers:	None
Injuries:	Pilot fatally injured
Other damage:	None
Light conditions:	Daylight

3 All times in this report are local times, which are equal to UTC + 2 hours.

1 INTRODUCTION

On 29 June 2022, the Rolladen-Schneider LS1-d, a single seater glider with registration D-2057, took off from Terlet glider airfield by the winch launch method. The glider immediately made a steep climb after becoming airborne. At a height of approximately 20 metres, it made a slight roll movement to the right followed by a transition to a left roll. The nose of the glider dropped and the glider started to rotate counter clockwise. Then, the glider crashed into the ground and came to rest upside down. The pilot was fatally injured and the glider was destroyed.

In accordance with the Dutch Safety Board Act, ICAO Annex 13[4] and European Union regulation No 996/2010[5], the Dutch Safety Board (on behalf of the state of occurrence) conducted the safety investigation of this accident. The Board notified the German Federal Bureau of Aircraft Accident Investigation (BFU) of the accident, as Germany is the state of design and the state of manufacture of the LS1 glider. The European Union Aviation Safety Agency (EASA) appointed a technical adviser. The Royal Netherlands Aeronautical Association (KNVvL) provided assistance during the investigation.

This investigation into this accident answers the following question:

> What was the cause of the glider crash during the winch launch?

Air safety investigators of the Dutch Safety Board carried out the first examination of the glider wreckage at the accident site. Investigators interviewed witnesses to the accident, such as several members of the gliding club. They also reviewed, among other things, the glider's flight documents, maintenance documents and data provided by the gliding club. Two weeks later, investigators further examined the wreckage, with assistance provided by a glider technician. Film recordings of the accident were available. The Dutch Aviation Police provided the Dutch Safety Board with additional witness statements.

Chapter 2 of this report provides the factual information gathered and considered relevant. In Chapter 3, the accident is analysed. The findings and conclusions from the previous chapter are combined and listed in Chapter 4.

4 ICAO, *Annex 13 to the Convention on International Civil Aviation: Aircraft Accident and Incident Investigation*, July 2020.

5 European Union, *REGULATION (EU) No 996/2010 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC*, October 2010.

2 FACTUAL INFORMATION

2.1 History of the flight

On Wednesday 29 June 2022, the pilot assembled his Rolladen-Schneider LS1-d (hereafter LS1), a single seater glider with registration D-2057. He had performed the inspection of the glider after which he made three short flights with it from Terlet glider airfield by using the winch launch method. At 14.57 hours, he took off from Runway 22L for his fourth flight that day with the LS1 also using the winch launch method. The water tanks in both wings were empty. A blue weak link was used.[6] According to a witness, who had observed the entire flight, the glider immediately made a steep climb after becoming airborne, after which the rate of climb decreased at a height of approximately 20 metres. Two other witnesses also stated to have seen the steep climb. Then, the glider made a slight roll movement to the right followed by a left hand turn with a steep bank angle. Then, the nose of the glider dropped and the glider started to rotate counter clockwise. The glider crashed into the ground and came to rest upside down. The pilot was fatally injured as a result of the crash. The nose and cockpit of the glider were destroyed, the fuselage was broken and the tail had broken off. The glider was damaged beyond repair. See Figure 1.

The winch operator stated that the winch functioned normally during the winch launch.

Figure 1: Accident location. (Source: Dutch Safety Board)

6 This weak link had a breaking load of 6 kN.

2.2 Personnel information

2.2.1 Pilot's licencing

The 69 year old pilot started gliding in 2016 and held a valid European Union Flight Crew Licence (LAPL(S)[7]) with the privilege winch launch, which was initially issued on 3 October 2019. He also held a valid medical certificate for class LAPL.[8]

2.2.2 Pilot's flying experience

The pilot's total flying experience was 171 hours and 30 minutes; he had made 715 flights.[9]

The pilot made the first flight on his LS1-d on 22 September 2021. In total, he had made 21 flights on the LS1 with a total duration of almost 3 hours, of which he made 13 flights in 2022, with a total duration of 1 hour and 28 minutes. During all those flights, the winch launch method was used.

In 2022 he had made 69 flights, as pilot in command, with a total duration of approximately 15 hours, where the winch launch method was used in all cases.[10] In addition to the LS1, he flew on gliders of the type Ka-7, Ka-8, ASK-13 and Scheibe Bergfalke that year. In the previous three years, he also flew these types; in addition, he then made 28 flights with an Astir.[11]

2.3 Aircraft information

2.3.1 General

The Rolladen-Schneider LS1 is a single-seat glider with a wingspan of 15 metres, manufactured in Germany. It made its first flight in 1968.

The LS1-d has a stabilator (pendulum elevator or all flying tail).[12]

2.3.2 Registration and airworthiness review

D-2057, with serial number 94, was manufactured by Rolladen-Schneider Flugzeugbau GmbH[13] in Germany in 1972. The date of issue of the certificate of registration, indicating the pilot as owner of the glider, was 25 August 2021.

7 LAPL(S) stands for Light Aircraft Pilot Licence (Sailplane).
8 With the limitation VNL, which stands for correction for defective near vision.
9 The pilot had filled in his logbook until 29 October 2021. He was a member of a local gliding club. The records of the club were used to determine his flying experience after this date.
10 The accident flight is included in these figures.
11 The investigators examined the pilot's logbook in which the first mentioned flight took place on 22 June 2019 more closely.
12 A stabilator is a fully movable horizontal stabilizer. The LS1 versions prior to the f version have (in opposite to the LS1-f) a stabilator.
13 Rolladen-Schneider Flugzeugbau GmbH (LS) was taken over by DG Flugzeugbau GmbH in 2003.

On 6 January 2009, the certificate of airworthiness, which was on board the glider, was issued by the Federal Office of Civil Aviation of the Federal Republic of Germany. The glider had a valid airworthiness review certificate, which was issued on 7 October 2021 and valid for one year. The glider had also had its annual inspection on that date. No defects to the glider were noted in the glider's logbook, that had not yet been rectified.

2.3.3 Weight and balance

The minimum load in the seat (pilot and parachute) of the LS1-d is 75 kg and the maximum load is 110 kg.[14]

The empty weight of an LS1 is approximately 200 kg. The maximum takeoff weight and landing weight with water ballast in the wings is 341 kg.

The weight of the pilot was approximately 88 kg. The pilot was wearing a parachute weighing approximately 7 kg during the accident flight.

2.4 Meteorological information

Meteorological information of the day of the accident was provided by the Royal Netherlands Meteorological Institute (KNMI).

On the flank of a high-pressure area over Denmark, a weak southerly current carried transformed polar air.

At the time of the accident, the temperature was 27 °C and there were visual meteorological conditions over Terlet. The ground wind came from a south-southeast direction with a speed of around 7 knots. The thermals were moderate to good and the build-up was unstable to 5,000 feet.

2.5 Survival aspects

The LS1 series gliders belongs to the first generation of composite gliders, which did not yet have a reinforced safety cockpit. There is no requirement to have such a cockpit. Reinforced cockpits increase the chance of survival in a crash.

2.6 Technical examination

The wreckage was examined with assistance provided by a glider technician. The nose section and the cockpit of the glider were destroyed. Therefore the position of the trim could not be determined. No technical defects were found in the flight controls.

14 Unless limited by the maximum permissible mass of the non-lifting parts (212 kg).

2.7 Additional information

2.7.1 Flight Manual information

The Flight Manual for the sailplane LS1-d, issued in January 2003 by Rolladen-Schneider Flugzeugbau GmbH states, among other things, the following about the winch launch in the Section Normal procedures.

> Keep control stick during takeoff roll in normal position, not fully forward. Apply forward pressure when entering transition, because of pitch-up tendency especially with rear centre of gravity positions.

The Flight Manual LS1, issued in May 2011 by DG Flugzeugbau GmbH states the following about the winch launch in Section 4.4, Normal procedures and recommended speeds.

> **Winch launch**
>
> Winch launch is only permitted at the centre of gravity tow hook!
> Set trim slightly nose down for a winch launch. Keep the control stick neutral during takeoff roll, don't push the stick forward.
> Apply forward stick when entering transition, because of pitch-up tendency, especially with rear centre of gravity positions.
> After reaching safety altitude gradually pull the stick backwards to avoid excessive speed pick-up.
> When reaching release altitude, pull the tow release knob.
> The recommended winch launch airspeed is 100-110 km/h (54-60 kts).
>
> Caution: Do not fly at less than 90 km/h (49 kts.) or not more than 110 km/h (60 kts.) resp. 120 km/h (65 kts), LS1-d.

2.7.2 The winch launch

Winch launching is an effective and safe method of launching a glider. The winch launch is a critical flight phase. It is therefore vital that procedures are followed strictly during the winch launch, which consists of the ground run, the rotation and the main climb.

A stall at low height during a winch launch is very critical, as a recovery from it is most likely impossible. This risk must therefore be anticipated and prevented. During both theoretical and practical training to become a glider pilot, much attention is paid to the safe execution of the winch launch.

2.7.3 Relevant publications

There are various publications in which attention is paid to the safe execution of the winch launch. The basic flight training manual of the Royal Netherlands Aeronautical Association (KNVvL)[15] states that 'after becoming airborne, as soon as the speed is sufficient, the climb angle can gradually be increased. Do not try to accelerate quickly, but gradually go to the full climb position. Normally it takes about 5 seconds to reach the climb position. With a slower winch launch or with a winch with less power, this takes longer'.

The dangers of a winch launch that is too steep are described as follows in the student pilot manual[16] of the British Gliding Association (BGA).

> The dangers of climbing too steep at low altitudes are serious. If you exceed the critical angle of attack, the airflow will separate from the wing, the lift will decrease and the drag will increase and you could enter a stall. That is why you slowly increase the climb angle during a winch launch with adequate speed and continued acceleration. If you fly the launch safely, you should always be able to recover from a launch failure regardless of the height or circumstances.

Exceeding the critical angle of attack is illustrated in the figure below.

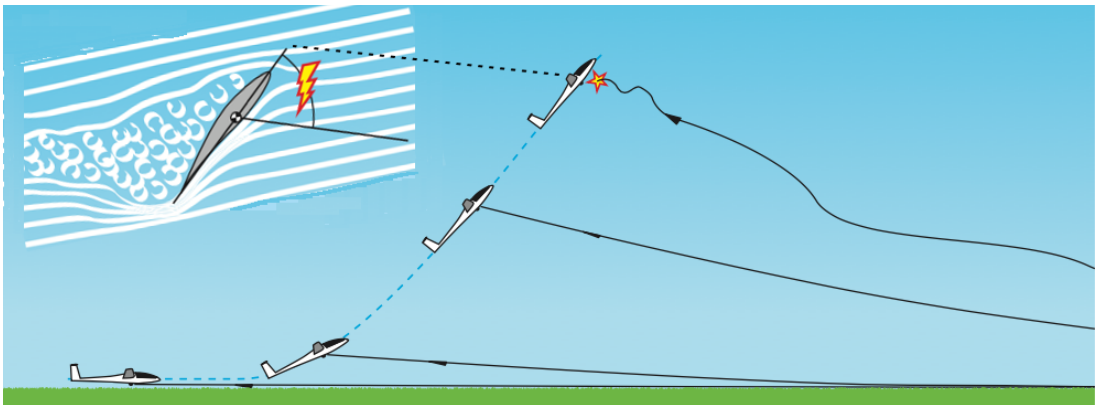

Figure 2: Exceeding critical angle of attack during winch launch. (Source: KNVvL)

The KNVvL published the book Safe gliding in which, among other things, attention is paid to stalling and accidents during the winch launch.[17]

15 KNVvL, Dirk Corporaal, *Zweefvliegen Elementaire vliegopleiding*, December 2022 (last updated).
16 The British Gliding Association, Dirk & Roelof Corporaal, *Gliding, Student Pilot Manual*, December 2021.
17 KNVvL, Gliding department, *Veilig Zweefvliegen*, 1997.

The Gliding Safety Committee of the KNVvL published the article 'Loss Of Control In-flight (LOC-I) situations with gliders'.[18] This was in response to the fatal accident after an interrupted winch launch with an LS8 glider at Gilze-Rijen Air Base in July 2020.

The British Gliding Association (BGA) published the booklet Safe Winch Launching.[19] Amongst others, the booklet highlights the key risk areas in winch launching and offers simple but effective guidance on how to minimise these risks. The booklet contains the following advice to avoid a stall during rotation.

- Avoid taking off with a significant amount of yaw present.
- Maintain a shallow climb until adequate speed[20] is seen, with continued acceleration.
- Ensure that the transition from level flight at take off to the full climb (typically 35°) is controlled, progressive, and lasts at least 5 seconds.

Similar accident

The Dutch Safety Board investigated a similar accident with a DG-808C, a single seater glider, that took place at Malden glider airfield in the Netherlands in June 2013. The glider took off by the winch launch method. It immediately made a steep climb after becoming airborne. At low height, the right wing dropped. The glider then attained a nose-down attitude, started to rotate clockwise and crashed into the ground. The pilot was fatally injured as a result of the crash. The glider was damaged beyond repair.

The accident occurred because the pilot allowed the glider to rotate too much during the start of the winch launch, causing the glider to obtain a high pitch attitude. As a result, the critical angle of attack was reached and the glider stalled and crashed.

The report on this investigation is published on the Dutch Safety Board's website.[21]

18 http://www.cvz.zweefportaal.nl/downloads.php?cat_id=3&download_id=14 (consulted on 6 April 2023).
19 British Gliding Association, *Safety Briefing, Safe Winch Launching*, January 2021.
20 The predetermined minimum safe airspeed on the airspeed indicator (typically 1.5 times the stalling speed).
21 https://www.onderzoeksraad.nl/en/page/2984/neergestort-tijdens-lierstart-dg-808c-5-juni-2013

3 ANALYSIS

Cause of the accident
The glider immediately made a steep climb after becoming airborne during the winch launch. The slight roll movement of the glider at a low height to the right was the first indication of a stall condition. Generally speaking, lateral instability is a first onset to a stall. The pilot's response to this resulted in stall with a wing drop to the left with a steep bank angle. The glider had now entered a fully stalled condition, its nose dropped and it then crashed into the ground. The glider entered a stalled condition just after becoming airborne with a high rotation rate because the critical angle of attack had been exceeded.[22]

A witness, standing on the strip from which the aircraft took off, stated that at a height of approximately 20 metres the rate of climb appeared to decrease. This may have been an indication that the pilot moved the control stick forward. However, this could not be confirmed from the film recordings.

The glider stalled at low height because the critical angle of attack had been exceeded, which was initiated by a high rotation rate in the beginning of the winch launch. The pilot was not able to recover from the stall.

The accident with D-2057 can be classified as a loss of control in-flight (LOC-I) accident. LOC-I accidents often result from failure to recover from a stall or upset. Data shows that for glider operations, aircraft upset is by far the highest safety risk with the potential of loss of life.[23,24] Inappropriate flight control inputs is identified as a factor strongly contributing to the aircraft upset risk area.

It has not been established whether the properties of the stabilator played a role in the present accident. If the acceleration during the winch launch is strong, a tendency to a pitch up movement of the glider can arise, which is difficult to control with a stabilator. The reason for the latter is, that if the pilot puts the stick completely forward, the stabilator will get an angle of attack, which is higher than that of the main wing. This means that with the stick pushed completely forward, the flow on the stabilator will separate before the flow on the main wing does, which limits the controllability of the glider. The available film recordings of the accident do not show whether the pilot pushed the stick completely forward during the start of the winch launch.

22 The high rotation rate has been identified in several studies as a major factor in raising the 1G stall speed up to 40% (Boundaries of Safe Winch Launching; Hugh Browning, OSTIV Congress, Eskilstuna, Sweden, 8-15 June 2006).
23 The safety risks are derived from European accident and serious incident data covering the period 2017-2021.
24 European Union Aviation Safety Agency (EASA), *Annual Safety Review 2022*, 2022.

Wreckage examination
The technical investigation of the wreckage, insofar as this was still possible because of the damage the glider sustained, has not revealed any technical defects in the flight controls that could have played a role in the accident. Regarding the previous three flights with the glider on the day of the accident, the pilot had not reported any problems or issues, such as related to the flight controls, to club members present at the airfield that day.

The trim position could not be determined because the nose and cockpit of the glider were destroyed.

No technical defects were found in the flight controls that may have played a role in the accident.

Weather conditions
There was a gentle breeze; it is considered unlikely that weather conditions were a factor in the accident.

The weak link used
The winch functioned normally and no cable or weak link breakage had occurred.

A blue weak link with a breaking load of 6,000 N was used for the winch launch, while the flight manual states a maximum value of 5,500 N and recommends a value of 5,000 N (+/- 500N) for a winch launch. The cable forces are relatively low in the beginning of the winch launch after the initial acceleration, and peak during the latter stages of the launch.[25] Therefore, the use of the blue weak link did not play a role in the accident.

Effect of center of gravity position
The weight of the pilot was approximately 88 kg. Together with the emergency parachute, weighing 7 kg, and the pilot's clothes, the cockpit load (load in the seat) became approximately 100 kg. This was above the minimum cockpit load of 75 kg and below the maximum load of 110 kg, as mentioned in the flight manual. With this loading, the centre of gravity was in the forward half part of the permissible range.

Several witnesses stated that the glider immediately made a steep climb after becoming airborne. This behaviour of the glider corresponds to the pitch up tendency when becoming airborne as described in the flight manual. The flight manual also states that this pitch up tendency especially occurs with rear centre of gravity positions. As the actual centre of gravity was in the forward part of the permissible range, the position of the centre of gravity did not play a contributing role in this accident.

25 S. Zistler - FTAG Esslingen, *Flugphysik des Windenstarts und Auswirkungen auf die Flugsicherheit*, April 2021.

The weight and balance of the glider were all within the prescribed limits.

Pilot's flying experience

The pilot was an experienced glider pilot with a total number of 750 starts. Even though he had only been active as a glider pilot for 6 years, he had extensive recent experience in performing winch launches. Nevertheless, in 2022 his flying experience on gliders entirely made of glass fibre was limited to his LS1. He had made a total of 21 flights on this type. The other types he flew in 2022 were from older generations, which have other flight characteristics, such as more docile stall behaviour in comparison with the LS1. Whether the pilot's limited recent experience of flying gliders entirely made of glass fibre contributed to the accident, could not be determined.

4 CONCLUSIONS

The glider stalled at low height because the critical angle of attack had been exceeded, which was initiated by a high rotation rate in the beginning of the winch launch. The pilot was not able to recover from the stall.

No technical defects were found in the flight controls that may have played a role in the accident.

The weight and balance of the glider were all within the prescribed limits.

Gliding clubs regularly pay attention to the safe execution of the winch launch during the training of a glider pilot. This also happens during the day-to-day operation of gliding clubs. The Dutch Safety Board therefore does not consider it necessary to make a recommendation regarding this subject. Nevertheless, with the publication of this report, the Board once again highlights the risks of the winch launch method, in particular the stall during rotation, with the aim of raising awareness of the risks. The importance of being aware of these risks does not only apply to student pilots, but also to experienced pilots.

APPENDIX A

Responses to the draft report

In accordance with the Dutch Safety Board Act, a draft version of this report was submitted to the parties involved for review. The following parties have been requested to check the report for any factual inaccuracies and ambiguities:

- DG Aviation GmbH
- European Union Aviation Safety Agency
- German Federal Bureau of Aircraft Accident Investigation
- Gliding Adventures Europe
- Instructor on duty
- Ministry of Infrastructure and Water Management
- Relatives of pilot

The responses received can be divided into the following two categories:

- Corrections and factual inaccuracies, additional details and editorial comments that were taken over by the Dutch Safety Board (insofar as correct and relevant). The relevant passages were amended in the final report.
- Where the Safety Board has not adopted responses, the reason for this decision is explained. These responses and the explanation are set out in a table that can be found on the Dutch Safety Board's website (www.safetyboard.nl).

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