FINAL REPORT

ACCIDENT 5260/2019

State Commission on Aircraft Accidents Investigation

UL. CHAŁUBIŃSKIEGO 4/6, 00-928 WARSZAWA | EVENT NOTIFICTION: +48 500 233 233

FINAL REPORT

ACCIDENT

OCCURENCE Ref. No – 5260/2019

AIRCRAFT – GYROPLANE ZEN1, OM-M393

OCCURRENCE DATE AND PLACE – 19 November 2019, EPNC, Poland

This Report is a document presenting the position of the State Commission on Aircraft Accidents Investigation concerning circumstances of the air occurrence, its causes and safety recommendations. The Report was drawn up based on information available on the date of its completion.

The investigation may be reopened if new information becomes available or new investigation techniques are applied, which may affect the wording related to the causes, circumstances and safety recommendations contained in the Report.
Investigation into air the occurrence was carried out in accordance with the applicable international, European Union and domestic legal provisions for prevention purposes only. The investigation was carried out without application of the legal evidential procedure, applicable for proceedings of other authorities required to take action in connection with an air occurrence.
The Commission does not apportion blame or liability.
In accordance with Article 5 paragraph 6 of the 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 Article 134 of the Act – Aviation Law, the wording used in this Report may not be considered as an indication of the guilty or responsible for the occurrence.
For the above reasons, any use of this Report for any purpose other than air accidents and incidents prevention can lead to wrong conclusions and interpretations.
This Report was drawn up in the Polish language. Other language versions may be drawn up for information purposes only.

WARSAW 2021

Content

Abbreviations

Abbreviation	Meaning in English
AC/SP	Aircraft
AGL	Above ground level
CAA/ULC	Civil Aviation Authority of the Republic of Poland
INS	Instructor rating
LAPL	Light aircraft pilot licence
LMT	Local Mean Time
MM	Aircraft maintenance mechanic
SCAAI/ PKBWL	State Commission on Aircraft Accidents Investigation
UAG (L)	Ultralight autogyro (Land) rating
UAGP	Ultralight autogyro pilot rating
VNL	Near vision limitation

General information

Occurrence ref. No:	5260/2019			
Type of occurrence:	ACCIDENT			
Occurrence date:	19 November 2019			
Occurrence place:	EPNC, Poland			
Aircraft kind and type:	Gyroplane, ZEN 1			
Aircraft registration marks:	OM-M393			
Aircraft User/Operator:	"KOMPOL" aviation training center			
Aircraft commander:	UAGP holder			
Number of victims/injuries:	Fatal	Serious	Minor	None
	2	-	-	-
Domestic and foreign authorities informed about the occurrence:	ULC, EASA, LNVÚ (Letecký a námorný vyšetrovací útvar – Slovakia)			
Investigator in Charge:	Krzysztof Błasiak			
Investigating authority:	Państwowa Komisja Badania Wypadków Lotniczych			
Accredited Representatives and their advisers:	N/A			
Document containg the results:	FINAL REPORT			
Safety recommendations:	YES			
Recommendations addressees:	Aviation Artur Trendak, ULC, operators			
Investigation completion date:	20 December 2021 r.			

Summary

On 19 November 2019, the instructor pilot (hereinafter referred as the „instructor") conducted flight training. At around 12:00 LMT, the student pilot (hereinafter referred as the "student") took a seat in the cockpit and then the crew took off for a training flight. At around 12:05 the crew performed “touch and go” maneuver. After lift off from the grass runway, during a steep climb, about 20-30 meters AGL, one of the main rotor blades separated. The other one, dynamically unbalanced blade collided with elements of the fuselage, tail and propeller, causing their destruction. At that time, a number of elements separated from the aircraft. The gyroplane without the main rotor fell almost vertically and hit the surface of the grass runway.

As a result of the collision with the ground, the fuel tanks were unsealed and then the gyroplane burst into flames.

Behind the gyroplane, on the same runway, the AT-3 plane made the take-off run. The crew of the plane aborted the take-off and taxied to the gyroplane wreckage to help its crew. The rescue services were called upon. The gyroplane instructor was found unconscious outside the aircraft. As his clothes caught fire, the plane crew pulled the victim away from the wreckage, extinguished the burning clothes and proceeded to resuscitate. After a while, some persons from the airfield buildings arrived and extinguished the burning wreck. The body of the student was revealed in the wreckage. After a few minutes, the helicopter of the Medical Air Rescue and the fire brigade units arrived. The resuscitation of the instructor had no effect.

The investigation of the occurrence was conducted by Krzysztof Błasiak, PKBWL member.

During the investigation, PKBWL determined that the cause of the accident was the inflight separation of one of the gyroplane main rotor blades.

Contributing factors:

1) **Operation of the main rotor blades having long unknown operation time;**
2) **Incorrect maintenance of the gyroplane;**
3) **No pre-flight inspection on the day of the accident;**
4) **The design of the rotor blade connector, which contributed to the concentration of stresses inside the assembly part of the blades, which has an adverse impact on the fatigue durability of the main rotor blades and, in case of errors in the maintenance of the rotor, accelerates the destruction of the blade internal structure.**

After the completion of the investigation PKBWL proposed safety recommendations.

1. FACTUAL INFORMATION

1.1. History of the flight

On 19 November 2019, the instructor carried out flight training as part of his commercial activities.

The gyroplane used for the training was the property of the instructor. Numerous witnesses testified that the instructor used the aircraft very intensively for such purposes as: regular training of students, aviation competitions, aerial works.

On the day of the accident two students were flying alternately for about 1 hour each. Student #1 started training at 8:00. In his presence, the instructor moved the gyroplane out of the hangar located at the EPNC landing site. According to the testimony of the student #1, the owner stored the gyroplane in that place for several days. According to a witness, the owner had exclusive access to the hangar, therefore he was convinced that the gyroplane was protected against unauthorized interference. Student #1 noticed that the instructor did not perform a pre-flight inspection. The student noticed that fact because it was inconsistent with the instructions he received during the training. However, he only realized this fact after the accident occurred.

Student #1 performed training flights with the instructor from about 08:00 hrs to about 09:00 hrs. Then student #2 performed flights from 09:00 hrs to 10:00 hrs and then, from 10:00 hrs to 11:00 hrs, the training was continued by the student #1.

Around 11:00 hrs, after landing, the student #1 noticed that the instructor brought tools to the aircraft - wrenches for tightening bolts. Then the instructor worked on the rotor for a while with wrenches. Student #1 did not observe those works carefully, because he was busy talking to another person. The instructor, while working on the rotor, simultaneously conducted a conversation on a mobile phone.

Student #1 testified that in previous flights he noticed vibrations on the cyclic at a speed of about 90 to 100 km/h. He asked the instructor if the ad hoc works on the rotor were related to these vibrations. The instructor denied it. According to the testimony of the student #1, the gyroplane had a slightly skewed left wheel of the main landing gear, which, according to the instructor, had been damaged during a landing some time earlier.

After a break, around 12:00 hrs, the student #2 took place in the cockpit. The gyroplane took off again and around 12:05 the crew performed “touch and go” maneuver, i.e. landing and immediate take-off without stopping the aircraft. After lift-off, during a steep climb, about 20-30 meters AGL, one of the main rotor blades separated. The other dynamically unbalanced blade collided with elements of the fuselage, tail and propeller, causing their destruction. At that time, a number of elements separated from the aircraft and the gyroplane without the main rotor fell almost vertically and hit the surface of a grass runway.

As a result of the collision with the ground, the fuel tanks were unsealed and then the fuel inside the fuselage caught fire.

Behind the gyroplane, on the same runway, the AT-3 plane made the take-off run. The crew of the plane aborted the take-off and taxied to the gyroplane wreckage to help its crew. The rescue services were called upon.

The gyroplane instructor was found unconscious outside the aircraft. As his clothes caught fire, the plane crew pulled the victim away from the wreckage, extinguished the burning clothes and proceeded to resuscitate. After a while, some persons from the airfield buildings arrived, extinguished the burning wreck and revealed the body of the student #2 inside.

After a few minutes, the helicopter of the Medical Air Rescue and the fire brigade units arrived. The resuscitation of the instructor had no effect.

The fire brigade extinguished the burnt wreck and secured the scene for the purposes of further activities.

1.2. Injuries to persons

Table 1.

Injuries	Crew	Passengers	Other persons	TOTAL
Fatal	**2**			**2**
Serious				
Minor				
None				

1.3. Damage to aircraft

The accident gyroplane was destroyed. A number of fragments separated in flight, due to the dynamically unbalanced blade of the main rotor, which, after separation of the first blade, collided with the elements of the gyroplane fuselage, tail and propeller, causing their destruction. After hitting the ground, the remaining elements of the wreck were burnt as the result of the fuel fire, released from unsealed tanks.

1.4. Other damage

As a result of the fire, the grass covering the runway was scorched over an area of several dozen square meters.

1.5. Personnel information (crew data)

Instructor – male, aged 59, holder of UAGP, issued 11 June 2013 with the rating for UAG (L) valid until 11 June 2023 and the INS rating, valid until 19 August 19 2020.

The instructor was also a holder of aircraft maintenance mechanic certificate of unlimited duration (MM), issued by the Polish CAA on 7 February 2005 with the following ratings:

1) TM (A) - totality of aeroplane of weight no more than 495 kg,

2) TM (AG) - totality of autogyro of weight no more than 560 kg,

3) TM (PHG) - totality of powered hang glider.

The instructor had an Aviation Medical Certificate issued by the Polish CAA on July 5, 2019 with the VNL limitation:

1) Class 2, valid until 5 July 2020;

2) LAPL valid until 5 July 2021.

Flight time: no data available.

The Commission did not manage to find the documents confirming the instructor's flight time, however, it should be noted that the pilot was a person with significant flight experience and skills at the master level. He had experience in flying hang gliders, powered hang gliders, ultralight planes and gyroplanes. He was the Polish Champion in the powered hang glider class (17 times), as well as a gold medalist of the Powered Hang Glider World Championship - in 2005 and 2009. In recent years, he also achieved numerous sport successes in flying gyroplanes. At the time of the accident, the instructor was the current European Champion and World Vice-Champion in the GL-2 gyroplane class.

Student #2 – male, aged 39.
Flight time: no data available.

1.6. Aircraft information

The ZEN1 is a two-seat ultralight gyroplane. The main structural element is the composite fuselage. Two metal tail beams are attached to the fuselage. A double vertical empennage (vertical stabilizers and rudders) is mounted on the beams together with a horizontal stabilizer equipped with winglets. The empennage is also of composite structure. A metal mast is attached to the fuselage structure, and on its top a control head with a rotor is mounted.

Fig. 1. ZEN1 autogiro [source: Internet]

The two-blade main rotor of metal construction is manufactured and supplied in a complete set (blades + hub) by AIRCOPTER. The blades, are made of drawn aluminum.

Zen 1 is powered by a CA 912 ULT engine. It is a Rotax 912 UL engine, modified by AVIATION Artur Trendak by adding an Iveco turbocharger. It is equipped with a three-blade DUC composite propeller, which pitch could be manually changed.

Fixed tricycle landing gear with elastic main legs made of aluminum. Nose gear cushioned only by wheel pneumatic.

The cabin is accessible through a large door on the left and right side. The wide glazing ensures optimal visibility. Two ergonomic bucket seats can be set in 3 positions. Each seat is equipped with adjustable four-point belts.

Table 2. ZEN1 gyroplane – manufacturer data

Aircraft category	Ultralight gyroplane
Type/model	ZEN1
Manufacturer	Aviation Artur Trendak
Fuselage structure	Composite CFRP
Main rotor	Two-blade, fixed pitch, blades made of a light alloy profile, connected to each other and pendulum suspended.
Designation	The gyroplane can be used in the „ultralight" category for the recreation, sport, air show, and other purposes excluding the air transportation flights.

Seats	2
Rotor diameter	8,6 m
Rotor circle surface	58,05 m^2
Rotor blade chord	0,2 m
Overall length (without rotor)	4,90 m
Fuselage width	1,35 m
Cockpit interior width	1,25 m
Overall width	2,20 m
Overall height	2,80 m
Wheels diameter	0,35 m
Maximum take-off mass	450 kg
Empty mass	265 kg
Payload	185 kg
Reduction gear	1:2,43
Propeller	DUC FC Windspoon R
Propeller diameter	1,72 m
Fuel tanks capacity	2 × 42 litres
Never-exceed speed (V_{NE})	210 km/h
Maximum structural cruising speed (V_{NO})	175 km/h
Maneuver speed V_A	90 km/h
Minimum speed V_{min}	65 km/h
Engine model	CA 912 ULT (Rotax 912 UL engine, modified by adding the Iveco compressor by the Aviation Artur Trendak company)
Maximum take-off power	122 HP / 5800 RPM
Maximum continuous power	100 HP / 4800 RPM
Fuel type	Unleaded automotive gasoline minimum octane grade 95, recommended octane grade 98

Table 3. Accident aircraft data

Aircraft full designation	ZEN1 RST
Serial number	T&SG21715S
Year of manufacture	2015
State of manufacturer	Poland
Manufacturer	AVIATION Artur Trendak
State of Registration	Slovakia
Registration marks	OM-M393
Certificate of Airworthiness (CofA) No	RS366
CofA issued on	11.07.2016

CofA expiry date after the last renewal	11.07.2020
Engine type	Rotax 912
Engine serial No	6 771 771
Year of manufacture	2015
Propeller type	Vrtula Kaspar K2
Propeller serial No	684/14/09
Propeller year of manufacture	2015
Propeller diameter	1720 mm
Propeller blades number	3
Propeller blades material	composite
Last service date (100FH)	31.07.2019
Airframe time since new (on the service date 31.07.2019)	307 h 25 min
Airframe time to the next overhaul	Unknown on the day of the accident – overhaul required each 400FH
Number of cycles since new	Unknown – the last entry in the airframe log book dated 09.06.2019 gives the number of 420 cycles

Table 4. Rotor data of the accident gyroplane

Rotor blades fitted by the manufacturer – serial No	AAT&S 055-8,6-2.0
Year of manufacture of the rotor blades fitted by the manufacturer	2015
Rotor blades found on the wreckage - serial No	CA-051-M
The origin of the blades found on the wreckage	The rotor blades originated from the gyroplane s/n: CAA14075S reg. marks SP-XENS (the same owner)
Year of manufacture of the rotor blades found on the wreckage	2011
Time since new of the rotor blades found on the wreckage	Unknown – the gyroplane from which the blades originated, had 1710 FH on the day of the accident

Table 5. Gyroplane mass data

Maximum take-off mass	450 kg
Empty mass	265 kg
Payload	185 kg
Instructor body mass	Unknown
Student body mass	Unknown
Luggage mass	No luggage
Fuel and oil mass	Unknown – impossible to define due to wreckage fire

1.7. Meteorological information

Meteorological conditions did not affect the occurrence and course of the accident.

Table 6. Meteorological conditions in the time and place of the accident

Wind	southern – 170°, 8 mph
Visibility	above 10 km
Clouds	none
Temperature	13°C
Dew point temperature	6°C
Pressure	1021 hPa

1.8. Aids to navigation

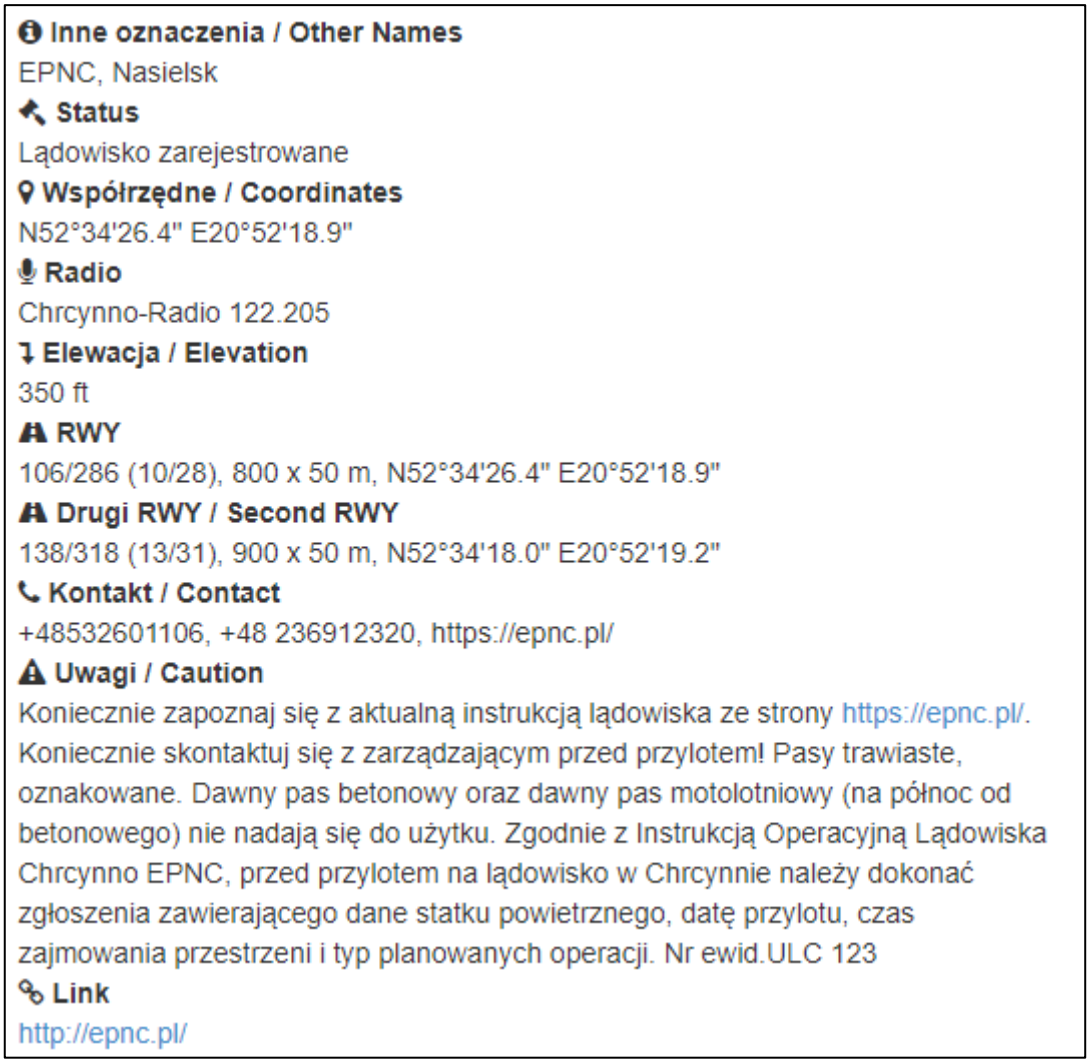
Not applicable

1.9. Communications

The crew maintained radio communication, which had no influence on the occurrence or course of the accident.

1.10. Aerodrome information

The gyroplane took off from the place described below.



Inne oznaczenia / Other Names
EPNC, Nasielsk
Status
Lądowisko zarejestrowane
Współrzędne / Coordinates
N52°34'26.4" E20°52'18.9"
Radio
Chrcynno-Radio 122.205
Elewacja / Elevation
350 ft
RWY
106/286 (10/28), 800 x 50 m, N52°34'26.4" E20°52'18.9"
Drugi RWY / Second RWY
138/318 (13/31), 900 x 50 m, N52°34'18.0" E20°52'19.2"
Kontakt / Contact
+48532601106, +48 236912320, https://epnc.pl/
Uwagi / Caution
Koniecznie zapoznaj się z aktualną instrukcją lądowiska ze strony https://epnc.pl/. Koniecznie skontaktuj się z zarządzającym przed przylotem! Pasy trawiaste, oznakowane. Dawny pas betonowy oraz dawny pas motolotniowy (na północ od betonowego) nie nadają się do użytku. Zgodnie z Instrukcją Operacyjną Lądowiska Chrcynno EPNC, przed przylotem na lądowisko w Chrcynnie należy dokonać zgłoszenia zawierającego dane statku powietrznego, datę przylotu, czas zajmowania przestrzeni i typ planowanych operacji. Nr ewid.ULC 123
Link
http://epnc.pl/

Fig. 2. Landing site data [source: www.lotniska.dlapilota.pl]

Fig. 3. Landing site aerial photo with basic data [source: www.lotniska.dlapilota.pl]

The landing site is listed in the register of landing sites of the Civil Aviation Office.

1.11. Flight recorders

The accident aircraft was not equipped with flight recorders. No recorder was required under the applicable regulations.

The accident was recorded by CCTV cameras installed on the EPNC landing site.

1.12. Wreckage and impact information

The accident occurred on the EPNC landing field, about 150 meters short of before the threshold of the runway in use. Geographical coordinates of the wreck location:
N 52°34'24 "; E 20°52'29 ".

To the left of the runway, about 80 meters from its centre line, the first of the main rotor blades was found. The blade was broken at the end of the blade connector and was in one piece, with no traces of collisions with other objects. The description "CA-051-M_B" was found on its upper surface.

Fig. 4. Fracture of the main rotor blade, which was first detached from the connector [source: PKBWL]

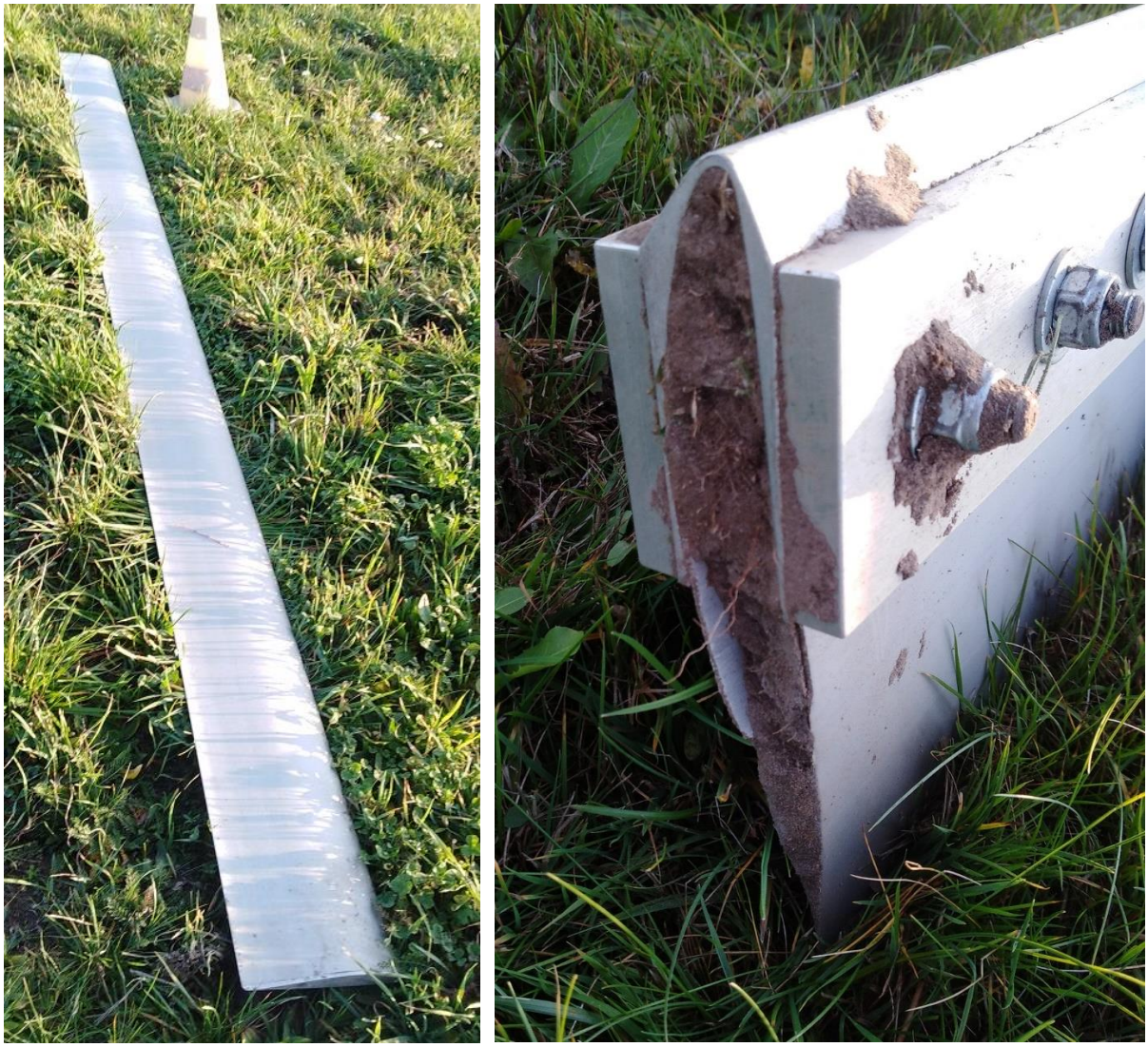


Fig. 5. Left: main rotor blade separated inflight; Right: blade connector on the main rotor hub - place where the first blade was separated [source: PKBWL]

Fig. 6. Marking revealed on the separated blade found on the accident site [source: PKBWL]

A cluster of scattered elements near the runway centre line in the direction of flight was found. They separated from the aircraft inflight. The larger elements included: the main rotor mast fairing (on the left of the runway) and a fragment of the left horizontal tail. The lower surface of the other blade showed numerous signs of collisions with the aircraft parts, and a complex, dynamic fracture traces were found on its part closer to the hub side. That blade was plastically bent towards the upper surface over most of its span.

About 30 meters further in the direction of flight, there was a fuselage impact mark on the runway surface. Around this trail, in a radius of 10 meters, there was a cluster of scattered small fragments of the wreck, such as: fragments of the door and fuselage glazing, door elements with a gas spring, antenna, front wheel of the landing gear, elements of clothing and personal belongings of the crew. Further 15 meters in the direction of flight, a completely burnt gyroplane wreck was located. The student's burnt body was revealed in the wreckage. The instructor's body was about 8 meters away and was not burnt.

Fig. 7. Marks of the fuselage collision the ground [source: PKBWL]

Fig. 8. The cluster wreckage that fell to the ground after the inflight disintegration of the gyroplane [source: PKBWL]

Fig. 9. The main rotor mast separated from the wreck [source: PKBWL]

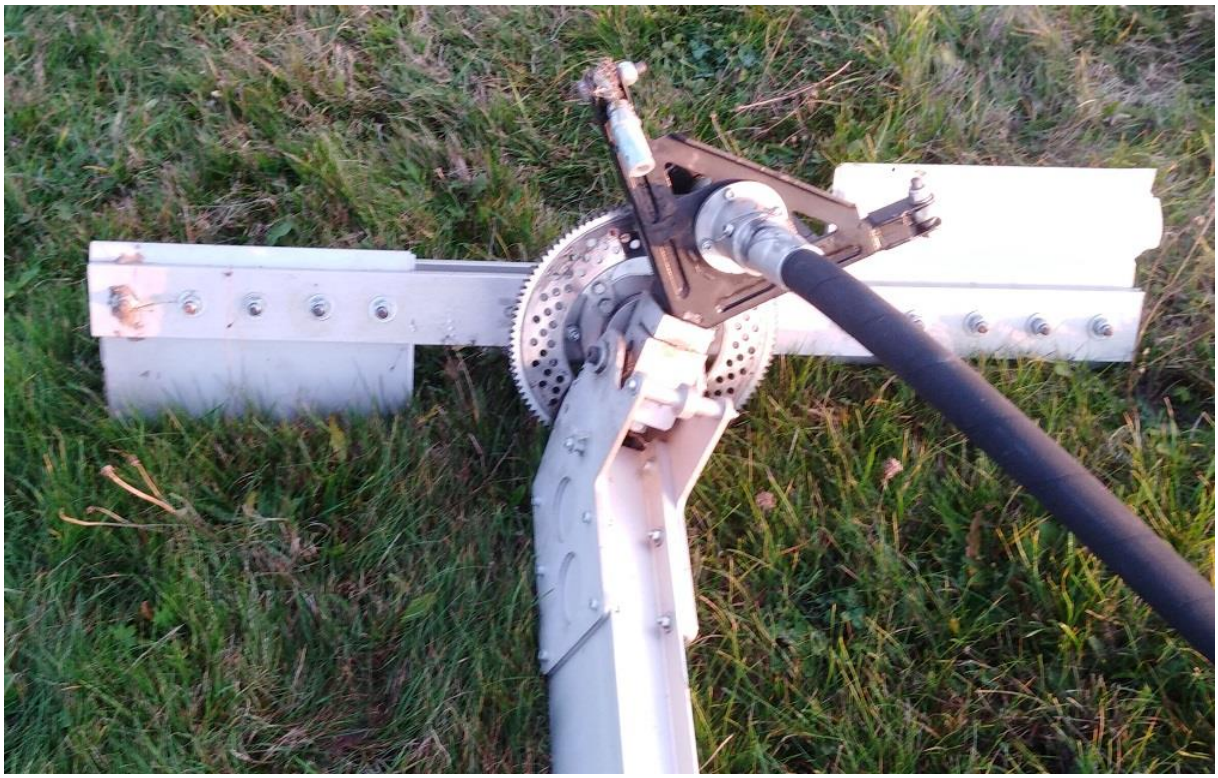


Fig. 10. The main rotor mast separated from the wreck - lower part of the hub. On the left, a fragment of the blade which was separated as first; on the right, a fragment of the other blade, damaged as a result of the accident [source: PKBWL]

Fig. 11. The blade destroyed due to the accident [source: PKBWL]

Fig. 12. View of the gyroplane rotor blades connector [source: PKBWL]

1.13. Medical and pathological information

The bodies of both victims were examined at the Department of Pathomorphology of the District Hospital in Maków Mazowiecki.

In the case of instructor, the features of exposure to open fire in the form of extensive burns of 2nd and 3rd degree of several dozen percent of the body surface, as well as extensive injuries to bones and internal organs were found.

In the case of student, the features of exposure to open fire were found in the form of extensive 3rd and 4th degree burns of almost the entire body, as well as a number of extensive injuries to bones and internal organs.

In both cases, the nature and location of the identified injuries indicated that they resulted from a fall from a height of several dozen meters and collision with the ground, and then exposure to open fire from a fuel explosion.

The direct causes of the death were:

1) In the case of instructor - extensive multi-organ trauma;
2) In the case of a student - acute multi-organ failure in the course of blunt multi-organ trauma and exposure to open fire.

No alcohol was found in the blood of any of the victims.

Based on the results of the above examinations, no evidence was found showing that physiological factors impacted the flight crew performance.

1.14. Fire

After the collision with the ground the aircraft went up into flames. The explosion was recorded by a CCTV camera and occurred after about 3 seconds after hitting the ground. The cause of the explosion, and then the fire, was the unsealing of the tanks of the crashed gyroplane, and then the ignition of the spilled fuel. The fire covered the entire wreck and lasted about 8 minutes, until it was extinguished by persons coming from the airfield buildings. As a result of the fire, the wreck was burnt to the extent that prevented inspection of its systems. The fire did not affected the elements separated inflight.

1.15. Survival aspects

The location of the bodies of the accident victims leads to the following conclusions:

1) in case of the instructor - at the time of the accident his seat belts were unfastened or were fastened incorrectly;
2) in the case of the student - at the time of the accident his seat belts were fastened correctly.

The circumstances of the accident - close to vertical trajectory of the gyroplane fall from several dozen meters and the immediate extensive fire in the wreckage did not give the crew any chance to survive. The accident gyroplane is a lightweight structure with a composite cabin. This type of structure does not provide sufficient protection to the persons on board during a collision with the ground after a fall from several dozen meters.

Immediately after the impact, an attempt was made to resuscitate the instructor, who was found outside the wreckage. The resuscitation failed due to numerous internal injuries sustained by the victim during the accident.

1.16. Tests and research

1.16.1. Tests and research carried out by the PKBWL Investigation Team

A number of tests and analyzes were conducted in the fields of:

1) Technical and operational records of the gyroplane - information on the structure of the gyroplane and the history of its service and operation was obtained and analyzed.
2) Human Factor:
   - information on the instructor authorizations, ratings and experience was obtained and analyzed;
   - statements of witnesses were collected regarding the crew activities carried out as part of the preflight gyroplane preparation;
   - data on aero-medical examinations of the instructor were obtained and analyzed;
   - data on autopsy and reports on the tests for alcohol were obtained.

1.16.2. Determining the cause of damage of the gyroplane main rotor blade.

As part of the investigation, PKBWL commissioned a comprehensive research of the main rotor blade and the rotor hub of the accident gyroplane. The research was performed by the Department of Advanced Materials and Technologies at the Faculty of Materials Science and Engineering of the Silesian University of Technology.

1.16.2.1. Purpose and scope of the research

The purpose of the research was to determine the cause of damage to the blade and the rotor hub of the ZEN1 gyroplane, which was involved in the accident on 19 November 2019. In particular, it was planned to determine:

- nature and course of the blade destruction;
- strength parameters of the blades material;
- quality of the blades workmanship;
- the torques applied to the bolts of the blade connector when they were tightened.

In order to achieve the planned goals, the following tests were carried out:

- visual examinations;
- measurement of the torques applied to the bolts of the blade connector when they were tightened;
- examination by a stereoscopic microscope;

- examination by a scanning electron microscope with X-ray microanalysis of the chemical composition;
- tests of mechanical properties.

1.16.2.2. Examination results

Material for the examinations and visual examinations:

The material for the examinations was the damaged blade marked "CA-051-MB" along with the gyroplane hub, which were delivered for testing on 4 December 2019.

It was found that the blade which separated inflight has a fracture on its seating in the main rotor hub connector. At the fracture point, the greatest bending moment occurs during the operation of the main rotor blade. Based on visual examinations, it was determined, that the fracture had a variable topography, and the area that could possibly be the place of the crack initiation was selected for further research. The fracture area marked with arrows in Fig.15 was observed using a Hitachi S 4200 scanning electron microscope.

Fig. 13. ZEN1 rotor blade subjected to research [source: Silesian University of Technology]

Fig. 14. ZEN1 rotor blade subjected to research [source: Silesian University of Technology]

Fig. 15. The surface of the blade fracture. Places selected for examination with the scanning electron microscope [source: Silesian University of Technology]

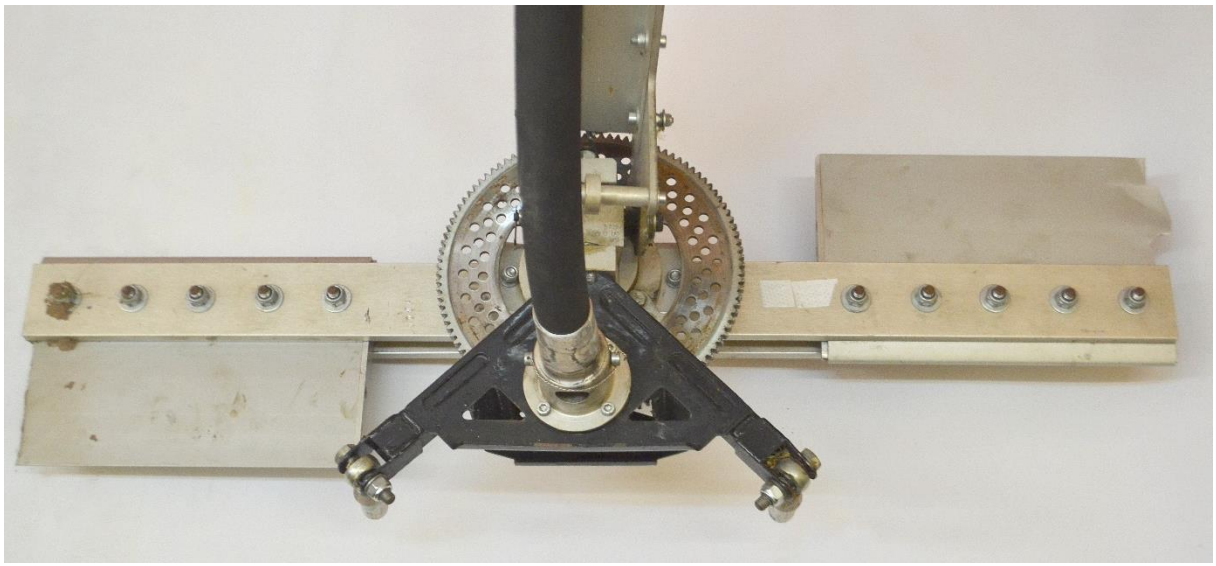


Fig. 16. The main rotor mast of the gyroplane subjected to the research - the lower part of the hub view. On the left, a fragment of the blade which was separated as first; on the right, a fragment of the other blade, destroyed due to the accident [source: Silesian University of Technology]

Determination of the torques applied to the bolts of the blade connector when they were tightened:

The measurements of the tightening torques was made with a torque wrench, changing the bolt loosening torque every 0.5 Nm. Fig.17 and 18 show the markings of the bolts used for their identification during the examinations, while Tables 7 and 8 show the results of the measurements of the torques necessary for their unscrewing.

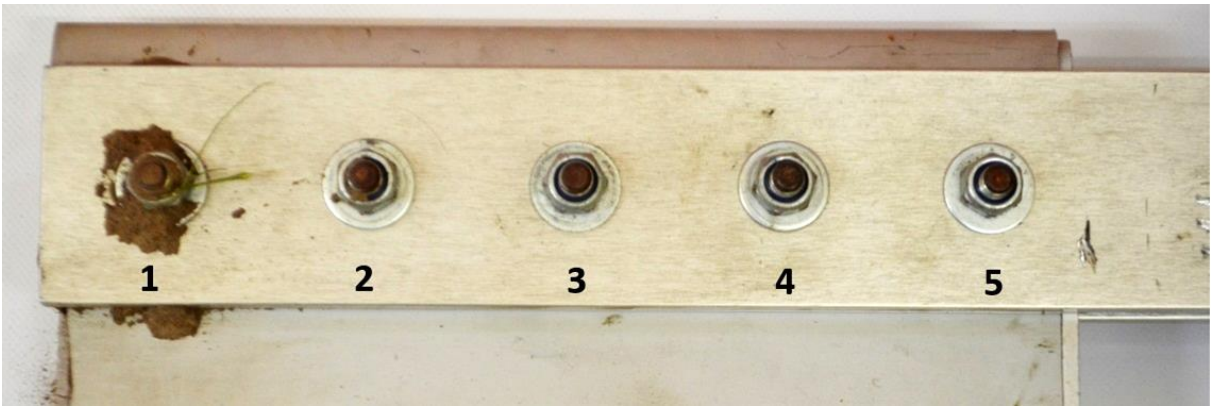


Fig. 17. Markings of the bolts of the blade detached as first [source: Silesian University of Technology]

Table 7. Results of measurements of the torques necessary for unscrewing the bolts showed in Fig. 17

Bolt 1	Bolt 2	Bolt 3	Bolt 4	Bolt 5
32,5 Nm	30,0 Nm	31,5 Nm	41,0 Nm	22,5 Nm

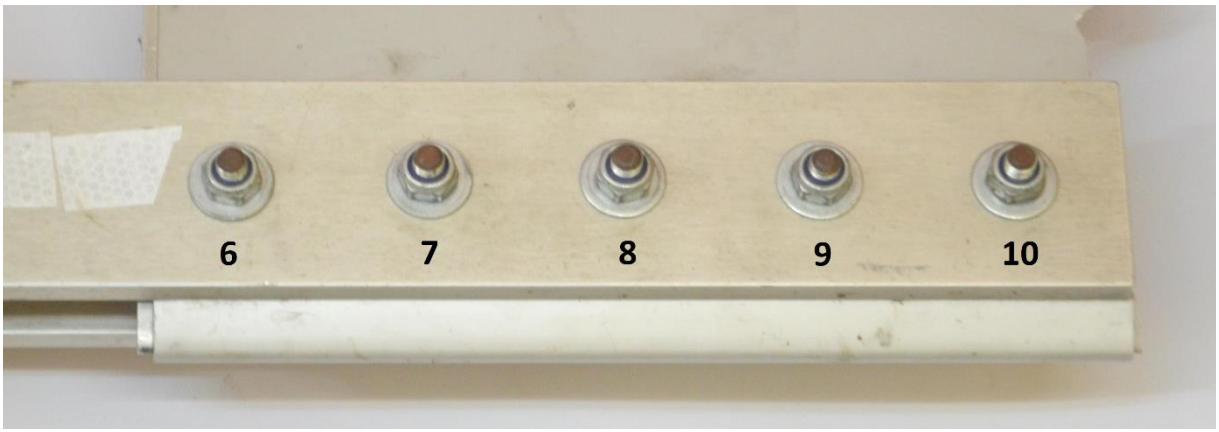


Fig. 18. Markings of the bolts of blade that broke due to destruction of the first blade [source: Silesian University of Technology]

Table 8. . Results of measurements of the torques necessary for unscrewing the bolts showed in Fig. 18

Bolt 6	Bolt 7	Bolt 8	Bolt 9	Bolt 10
43,5 Nm	43,0 Nm	43,5 Nm	44,0 Nm	43,5 Nm

Examination with a stereoscopic microscope:

Based on the observation with a stereoscopic microscope, it was determined that the fatigue fracture occurred on the upper and lower blade surfaces. The results of the observations are presented in the figures below.

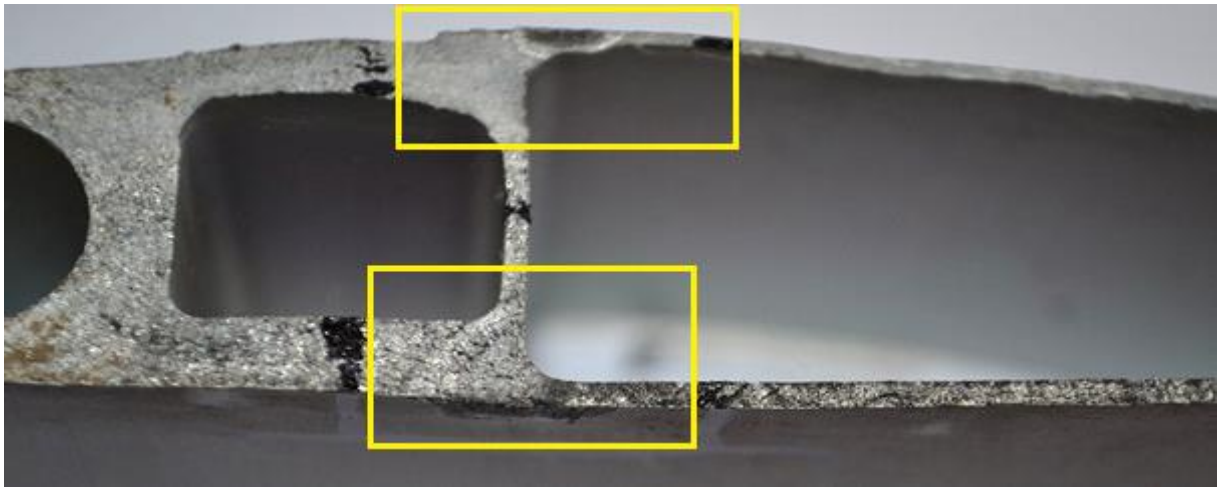


Fig. 19. Sampling areas for examination with the scanning electron microscope [source: Silesian University of Technology]

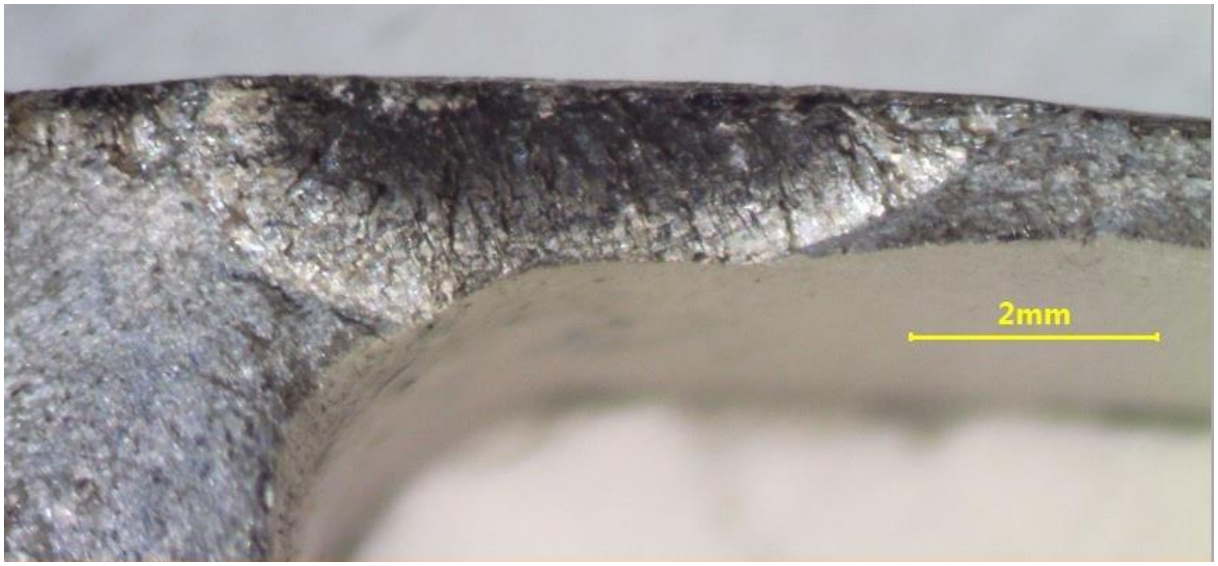


Fig. 20. Detail from fig. 19 - upper area. Visible place of the fatigue crack [source: Silesian University of Technology]

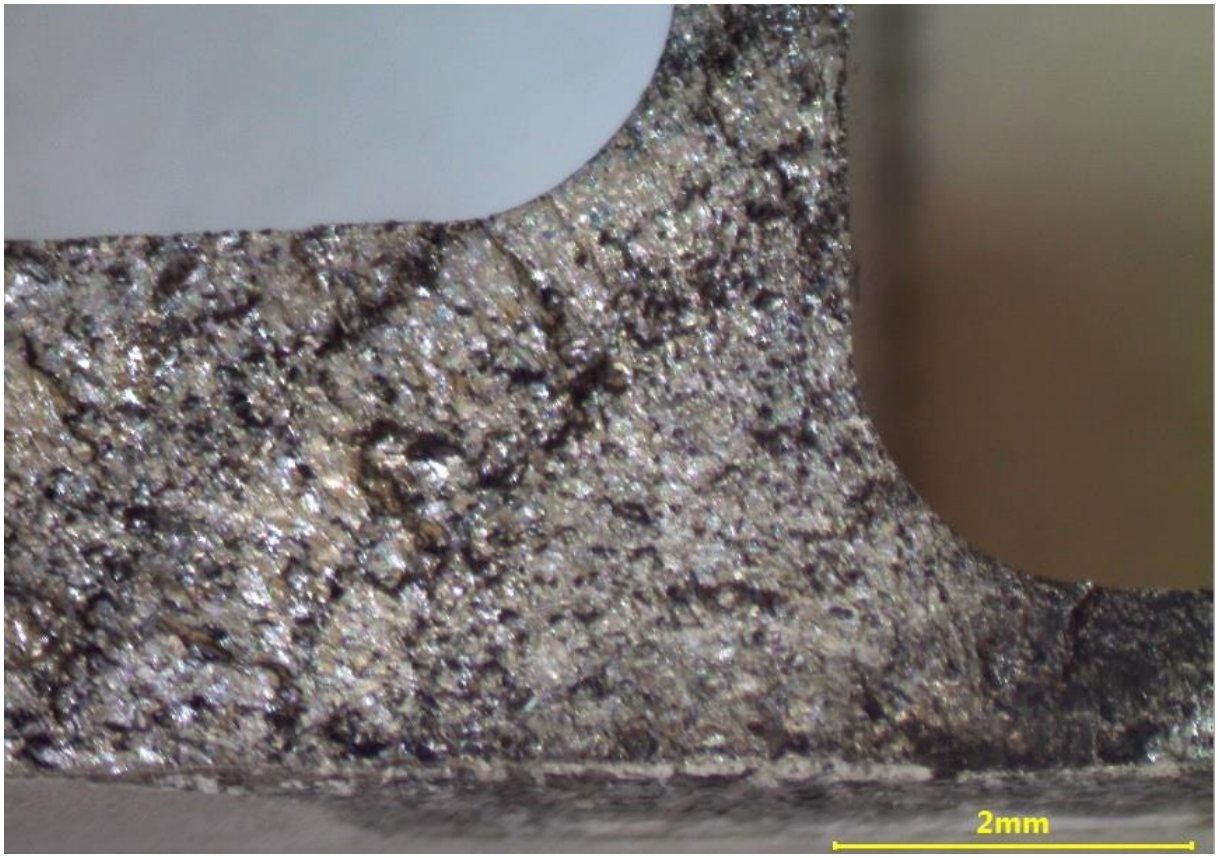


Fig. 21. Detail from fig. 19 - lower area. Visible place of the fatigue crack [source: Silesian University of Technology]

The surface examinations were carried out using the Hitachi S-4200 scanning electron microscope (SEM) together with the X-ray microanalysis of the chemical composition (EDS). The results of the observations are presented in the figures below. It has been shown that the material has a fracture typical of a fatigue crack. The focus point of the fracture is located in the outer zone of the blade in cases of both fatigue fractures.

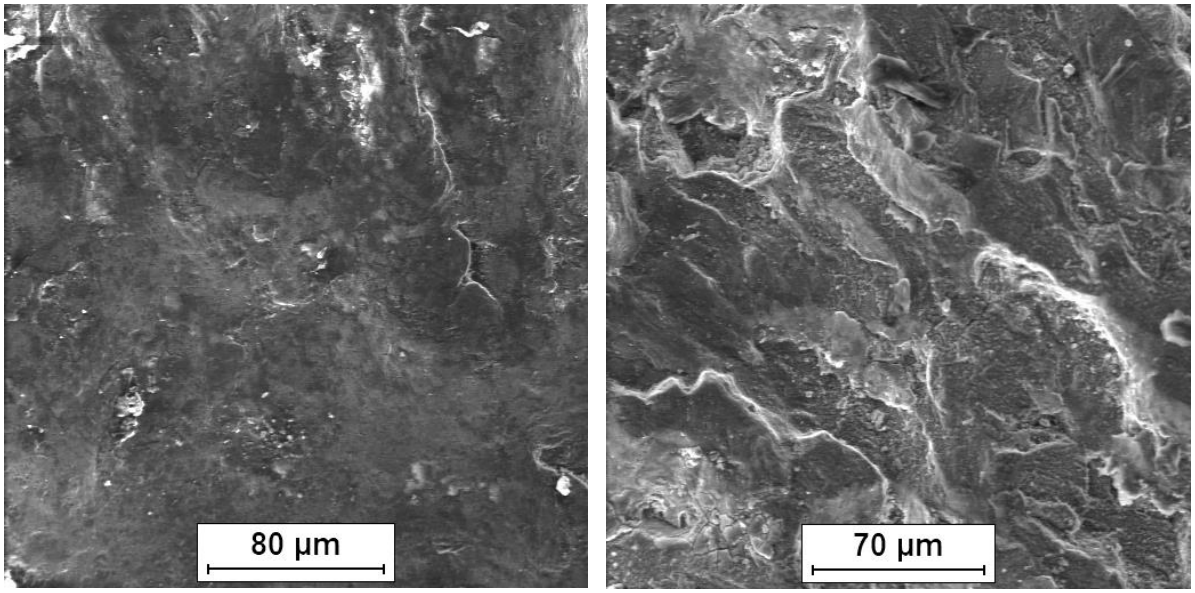


Fig. 22. Fatigue crack from the upper area marked in fig. 20. Visible light fatigue striations [source: Silesian University of Technology]

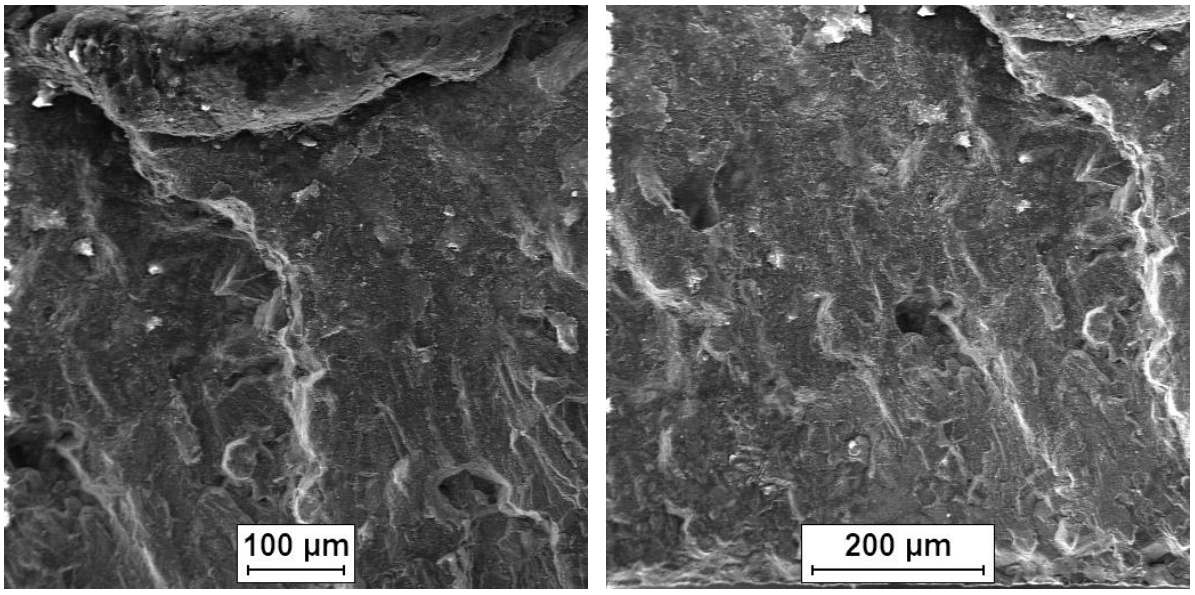


Fig. 23. Fatigue crack from the lower area marked in fig. 20. Visible light fatigue striations [source: Silesian University of Technology]

X-ray microanalysis of the chemical composition showed that the rotor blade was made of an alloy of aluminum and magnesium.

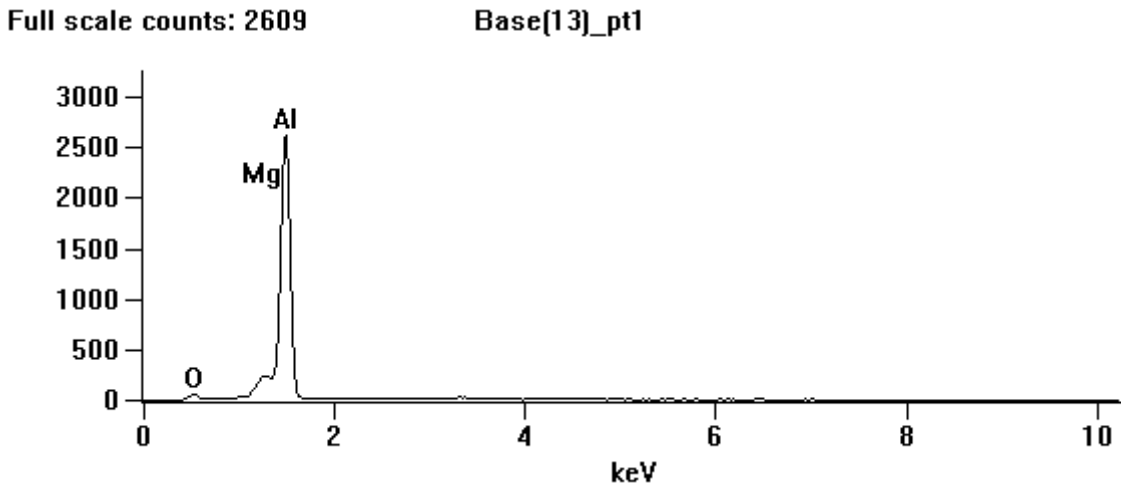


Fig. 24. X-ray microanalysis of the rotor blade chemical composition [source: Silesian University of Technology]

Table 9. X-ray microanalysis of the rotor blade chemical composition

	Mg	Al
Mass share %	5,5	94,5

Examinations of mechanical properties:

The static tensile test was carried out in accordance with the PN-91/H-04310 standard on flat samples cut from the blade and schematically presented in Fig.25. The parameters obtained during the examination are tensile strength (Rm), yield strength (Rp0.2) and elongation (A). The static tensile test was carried out on the ZWICK/ROELL testing machine Z100 THW. The results of the static tensile test are shown below. The dimensions of the samples as well as the plastic and mechanical properties of the material were determined based on the PN-91/H-04310 standard. Based on the examinations, it was not possible to determine the yield point, because the crack occurred earlier than the stress value at which plastic deformation occurs.

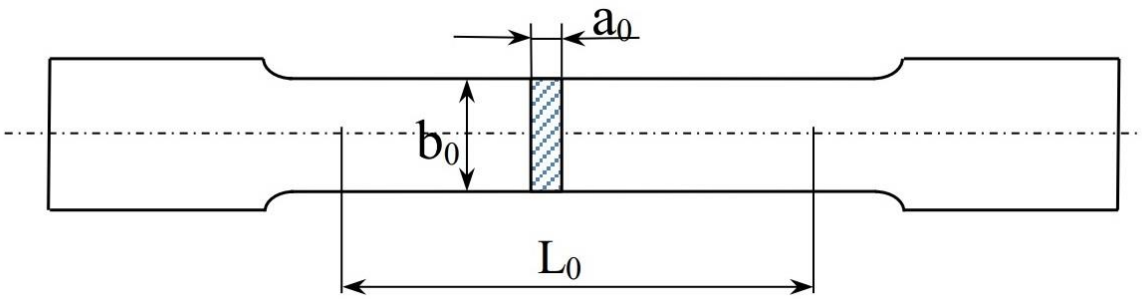


Fig. 25. A flat sample with the heads for static tensile test [source: Silesian University of Technology]

The basic dimension of flat test samples is their thickness a_0, i.e. the distance between the rolled surfaces that are not subject to machining. L_0 - datum length. The cross-sectional area of the sample before loading was:

$$S_0=a_0b_0$$

Table 10. Dimensions of the test samples before and after the tensile test [mm]

Sample marking	a_0	b_0	S_0	L_o	L_k	ΔL
1	1,46	15	21,9	50	55	5
2	1,44	15	21,6	50	56	6
3	1,45	15	21,75	50	-	-
4	1,45	15	21,75	50	55	5
5	1,46	15	21,9	50	55	5

where: Lk – final length, ΔL – legth increment.

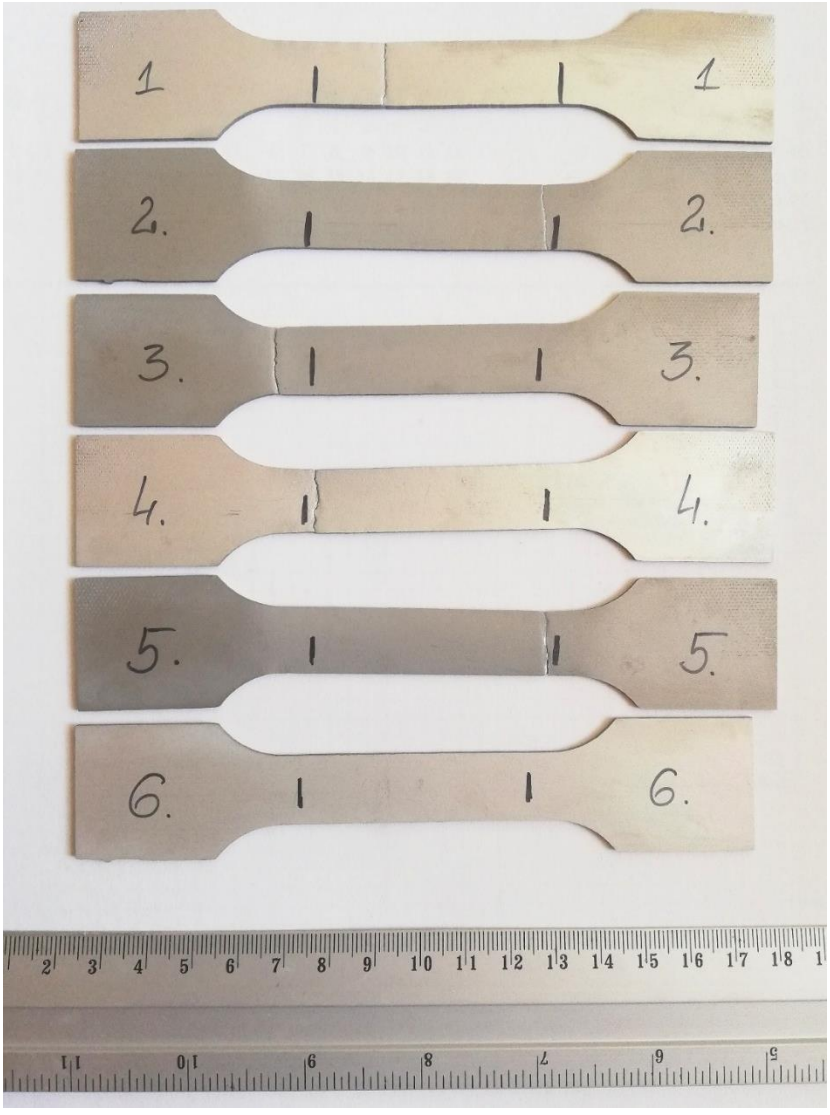


Fig. 26. Test samples after the static tensile test. „1" to „5" – tested samples; „6" - reference sample [source: Silesian University of Technology]

Table 11. Results of the static tensile test of the broken main rotor blade material

Sample marking	R_m, MPa	R_e, MPa	A, %
1	264	-	10
2	271	-	12
3	278	-	4
4	270	-	10
5	270	-	10

1.16.2.3. Conclusions from the examinations conducted

Based on the examinations, the following conclusions were drawn:

1) Blade no. 1, torn off inflight, sustained a two-phase crack. In the first phase, a fatigue crack occurred, which resulted in reduction in the active cross-sectional area of the rotor blade, and then, as a result of stress concentration, a sudden fracture occurred, as a result of which the blade separated into two parts (the smaller part remained attached with bolts inside the hub blade connector, and the remaining part came off inflight);
2) The fracture occurred in the zone of the greatest bending moment of the blade (at the end of the tabs holding the blade in the hub);
3) The material of the blade was alloy of aluminum and magnesium. The sudden breakthrough is typical for this type of material;
4) The mechanical properties of the material of the broken blade did not indicate that the reason of the crack could have been a decreased strength of the material;
5) Tightening torques for the bolts of the blade No. 1 (causal for the accident) were different, which indicates improperly performed assembly, repair or maintenance works on the examined element. The low tightening torque of the bolts could have caused the blade vibrations, and consequently, formation of fatigue cracks determined during the examinations. Propagation of the fatigue cracks and the resulting change in the stress could have been the cause of decohesion (detachment) of the blade;
6) The tightening torques for the bolts of the blade No. 2 (damaged after the first blade was torn off) had very close values for all 5 bolts of this blade;
7) No material defects were found that could have caused the crack of the blade No. 1.

1.17. Organizational and management information

The instructor manufactured gyroplane components and carried out training for gyroplane pilots. The accident flight was performed as part of his professional activity.

1.18. Additional information

None.

1.19. Useful or effective investigation techniques

The standard investigation techniques were used.

2. ANALYSIS

2.1. Operations

2.1.1. Crew qualifications

The Commission analyzed the collected documents, witness statements and the recordings from CCTV cameras located at the landing site. The Commission concluded that there were no irregularities in the qualifications and ratings of the crew that could affect the occurrence or course of the accident.

2.1.2. Operational procedures

The instructor, and also the owner of the accident gyroplane, kept it on EPNC during several days prior to the accident. The other student flying in the morning of the accident day noticed, that the instructor did not perform the pre-flight inspection of the gyroplane. That fact was inconsistent with the instructions he received during the training, however, he only realized that only after the accident. The lack of a pre-flight inspection was a violation of the applicable procedures. The inspection would probably reveal a fracture in the blade. It was not possible to visually detect the fracture, but during the inspection, pilots usually tap each blade and compare the sounds (this is a good practice not described in the ZEN1 flight manual). That type of verification „by ear" gave a chance to avoid the accident.

2.2. Aircraft

2.2.1. Aircraft technical maintenance

The scheduled maintenance of the accident gyroplane was carried out by the manufacturer - Aviation Artur Trendak company. On July 31, 2019, a 100H maintenance works were performed (equivalent of an annual maintenance, whichever comes first). The Commission has no concerns related to that maintenance.

The owner of the gyroplane had an aircraft maintenance mechanic certificate of unlimited duration (MM), issued by the Polish CAA on February 7, 2005 along with the TM (AG) certificate for gyroplanes with MTOW below 560 kg. Therefore, within the framework of that certificate, the owner performed routine, daily maintenance of the aircraft.

According to the information from the manufacturer, the main rotor is replaceable and may be replaced at any time. The replacement of the rotor is covered by normal procedures, therefore, it could have been performed by the pilot/owner in the scope of

his ratings. Each time when the gyrocopter is transported on a trailer, the rotor is removed.

The accident gyroplane left the manufacturer's premises with the original main rotor blades, marked: AAT&S 055-8,6-2.0. After the accident, it was revealed that the main rotor blades mounted on the gyroplane had the designation: CA-051-M.

The Commission found that the blades revealed on the accident gyroplane had been purchased by the pilot earlier, together with the gyroplane serial number: CAA14075S and registration marks: SP-XENS. The gyroplane and the blades were manufactured in 2011, i.e. earlier than the accident gyroplane.

The Commission has not been able to establish when the rotors were replaced, and what was the real service time of the rotor involved in the accident. The gyroplane from which the accident rotor originated, had a flight time of 1710 hours (according to maintenance organisation). The manufacturer limited the permissible rotor service time to 2000 flight hours.

The other student flying the accident gyroplane testified that in previous flights he noticed vibrations on the cyclic at a speed of about 90 to 100 km/h, and that the gyroplane had a slightly skewed left wheel of the main landing gear. According to the instructor the wheel had been damaged during a competition some time earlier. The accident gyroplane was regularly involved in aviation competitions and was used for training (sometimes 7 days a week from the morning to the evening). Additionally, the pilot sporadically performed aerial works (agricultural). Aerial works and competitions often produce heavy loads on the aircraft structure, and require a particular care from the pilot and maintenance personnel.

In the initial phase of gyroplane take-off run its rotor RPM are lower than in flight. This results in less centrifugal force acting on the rotor blades and hence its greater vulnerability to transverse loadings acting on a blade plane (e.g. loads from taxiing over uneven terrain). The deformed landing gear of the gyroplane noticed by the student proves that the aircraft was subjected to this type of loads, which could also have a negative impact on the durability of the rotor blades. Excessive vibrations on the cyclic during flight, could also indicate a deteriorating mechanical condition of the rotor. The instructor ignored these symptoms and performed ad hoc work on the rotor, contrary to the maintenance manual. The assembly of the rotor and blades in the head should be carried out with torque wrenches and tightening torques specified by the manufacturer. Before the accident, the instructor tightened the blade bolts with an ordinary wrench, which makes it impossible to perform this procedure properly. The fact of different tightening torques was also confirmed by the tests described in item 16.222. In addition, the pilot was distracted by talking on the phone.

In the light of the above facts, the accident was only a matter of time.

2.2.2. Aircraft technical parameters

The ZEN1 gyroplanes meet the airworthiness requirements in accordance with the Certificate of Compliance under Technical Requirements No. USP-005 issued by the Polish CAA on February 20, 2012. In the opinion of the Commission, despite the formal compliance with the requirements of the above Certificate, the structural solution of the gyroplane was the factor contributing to the occurrence of the accident.

The Commission's doubts were raised by the design of the hub and the main rotor blade connector, which caused an excessive strength load on the rotor blades. The main rotor blades of the ZEN1 gyroplane are manufactured in the form of a profile shaped by extrusion from aluminum alloy. The blades made in this way have a homogeneous material structure, and a crack causes rapid propagation of the damage in the blade material and leads to its destruction. The blade is attached to the gyroplane rotor hub through the cap and pressed with assembly bolts between the elements of the blade connector made in the form of two parallel flat bars with a constant cross-sectional area.

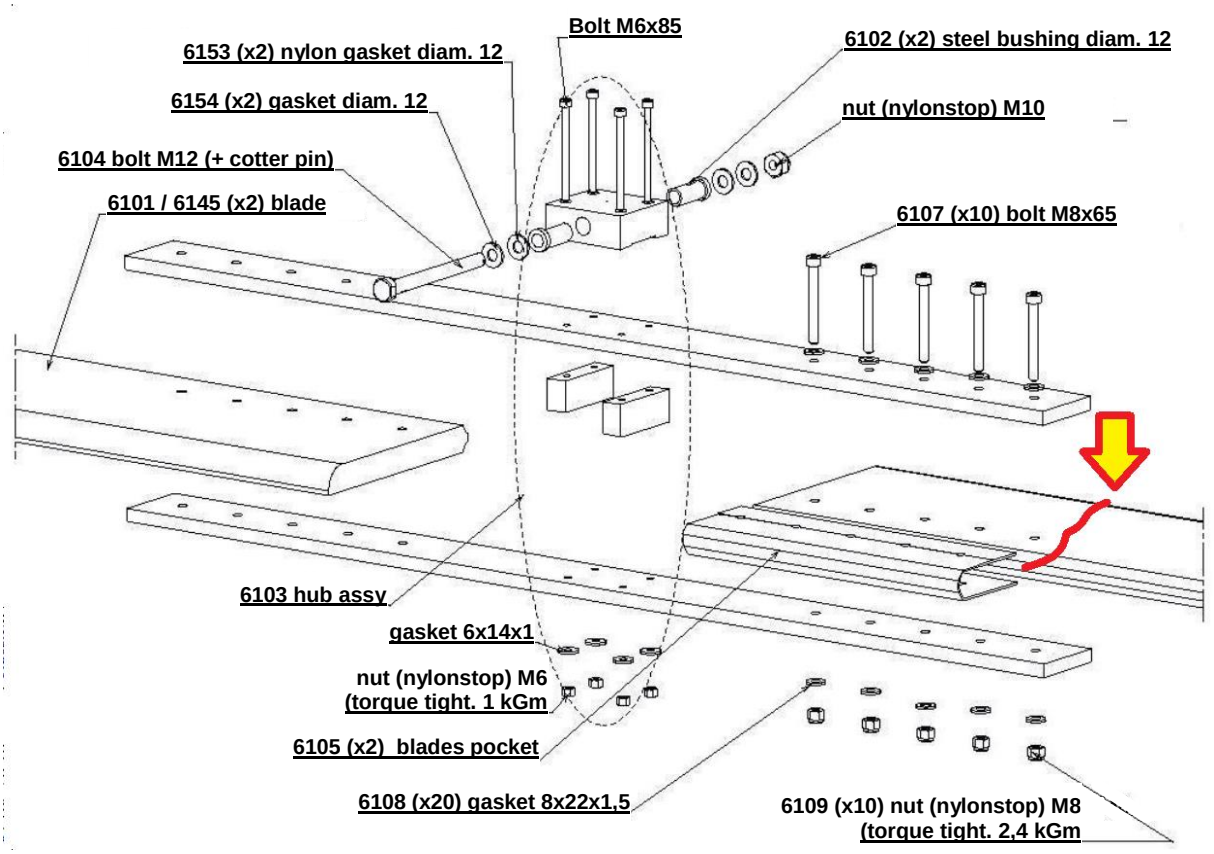


Fig. 27. ZEN1 gyroplane rotor hub assembly diagram. The arrow marks the place of the blade fracture. [source: ZEN1 gyroplane maintenance manual]

The blade of the working rotor of the gyroplane, generating the lift force, is bent towards its upper surface. The value of the bending moment is zero at its free end and increases as it approaches the axis of rotation of the rotor.

When the blades are fixed as shown in Fig. 27, the blade bending moment reaches its maximum at the edge of the flat bars of the connector. In terms of the mechanical strength, this is a very unfavorable condition, generating a stress distribution in the blade material similar to the stress distribution resulting from the notch effect.

The blades rotating during the flight are subjected to many forces. The resultant of these forces act to arrange the blades of the working rotor in the shape of a cone, which is counteracted by a rigid connector fixing the blades to the rotor hub. The maximum moment bending the blades is produced at the ends of the rigid connector and this is the place where the blade fracture occurred in the accident investigated.

There are design solutions that ensure a more favorable stress distribution in the working rotor blades. Currently, the standard in the design of rotors has become:

1) Variable cross-sectional area of the blade connector, which is the largest at the rotor axis and thus has the greatest stiffness, and decreasing towards the tip of the blade, which decreases its stiffness (Fig.28, 29 and 30);
2) Designing the blade connectors not in the form of flat plates, but in the form of a structure that fixes the blades with constant dihedral, so that the working blades form a cone surface (Fig. 31 and 32).

Both described solutions significantly reduce the load on the rotor blades. The first method, by gradual and controlled stiffening of the blade connector, reduces the stress concentration in the blade material at the point where the blade enters the connector. The second method reduces the blade bending moment during the rotor operation.

Fig. 28. Example of a gyroplane rotor blade connector with gradual change of its stiffness by changing its thickness [source: PKBWL]

Fig. 29. Example of a gyroplane rotor blade connector with gradual change of its stiffness by changing its thickness [source: PKBWL]

Fig. 30. Example of a gyroplane rotor blade connector with gradual change of its stiffness by changing its width [source: PKBWL]

Fig. 31. Example of a gyroplane rotor blade connector with dihedral reducing the bending moment acting on working blades [source: PKBWL]

Fig. 32. Example of a gyroplane rotor blade connector with dihedral reducing the bending moment acting on working blades [source: PKBWL]

The information obtained by the Commission clearly show that the ZEN1 gyroplane manufacturer considered application of the above presented designs, but did not do so due to limits in the manufacturing cost.

2.2.3. Aircraft mass

Due to the wreckage fire, it was not possible to determine the weight of the crew and the fuel on board the gyroplane. The Commission found that both the instructor and the student were of normal body structure and that there was no luggage on board. Based on that information, it was assumed that the take-off mass of the aircraft was not exceeded.

2.3. Human factor

2.3.1. Psychological and physiological factors affecting the crew

The instructor/owner of the accident gyroplane was a person with very high skills and aviation experience. Statements of numerous witnesses show that the instructor conducted very intense aviation activities, often 7 days a week from dawn to dusk.

Probably the conviction about his own high skills and many years of success in then aviation sports lulled the pilot's vigilance, who ignored a number of symptoms (damaged landing gear, structural vibrations) that informed the crew about the poor mechanical condition of the aircraft.

The instructor did not perform a pre-flight inspection of the gyroplane, as he was most probably convinced that he knew the condition of the aircraft and it did not raise any concerns, but in this way he deprived himself the possibility of avoiding the accident. The above omissions show the signs of irregularities caused by the phenomenon of routine.

Based on examinations of the crew's remains, the Commission did not find any physiological factors affecting them.

2.4. Survivability

The actions of the rescue and firefighting services were correct.

The direct causes of death of the crew:

1) In case of the instructor - extensive multi-organ trauma,
2) In case of the student - acute multi-organ failure in the course of blunt multi-organ trauma and exposure to open fire.

The circumstances of the accident - close to vertical fall from several dozen meters and the immediate occurrence of an extensive fire in the wreckage - did not give the crew any chance to survive.

3. CONCLUSIONS

3.1. Commission findings

Based on the analysis of the collected materials, the State Commission on Aircraft Accidents Investigation has made the following findings:

1) The instructor had the proper ratings to perform the flight in accordance with the applicable regulations;
2) The instructor had the valid aero-medical certificate;
3) The instructor had the aircraft maintenance mechanic certificate;
4) The Commission was not able to establish the instructor's flight experience, but based on the information collected, concludes that his experience and skills were sufficient to perform the flight;
5) The commission was not able to establish flight experience of the student;
6) As a result of the accident, the gyroplane crew died at the scene;
7) During the flight, the instructor did not have his seat belts fastened;
8) During the flight, the student has his seat belts fastened;
9) The circumstances of the accident did not give the crew any chance to survive;
10) The direct cause of the instructor's death was extensive multi-organ trauma;
11) The direct cause of the student's death was acute multi-organ failure in the course of blunt multi-organ trauma and exposure to open fire;
12) Immediately after the accident, an attempt was made to resuscitate the instructor, but it failed;
13) The actions of the rescue and firefighting services were correct;
14) There was no possibility to rescue the student, whose body remained inside the wreck after the accident;
15) The crew was not under the influence of alcohol;
16) The Commission assessed, that the mass of the aircraft was not exceeded at the time of the accident;
17) The accident flight was a part of the instructor's commercial activity;
18) The gyroplane was entered in the register of the Slovak Republic;
19) The instructor did not perform a pre-flight inspection of the aircraft;
20) The accident gyroplane left the manufacturer premises with the main rotor blades, marked: AAT & S 055-8,6-2.0;
21) After the accident, it was revealed that the rotor mounted on the gyroplane had the designation: CA-051-M;
22) On the day of the accident, the rotor service life specified by the manufacturer was 2000 h;
23) The gyroplane from which the accident rotor came from, had 1710 FH (according to instruments) on the day of the accident;
24) During the steep climb of the gyroplane, about 20-30 meters AGL, one of the main rotor blades separated;

25) Other damage to the gyroplane were secondary in nature and resulted from the destruction of the main rotor;
26) The gyroplane was destroyed as a result of the accident;
27) The accident resulted in a fire of the aircraft;
28) The fuel fire spread over the entire wreck and lasted about 8 minutes, until it was extinguished by persons coming from the aerodrome buildings;
29) As a result of the fire, the wreck was burnt to a great extent, making it impossible to inspect the condition of any of its systems;
30) The gyroplane main rotor blade torn off during the accident sustained a two-phase crack;
31) The blade as made of an alloy of aluminum and magnesium. The sudden breakthrough is typical for this type of material;
32) The mechanical properties of the material of the broken blade did not indicate that the reason of the crack could have been a decreased strength of the material;
33) Tightening torques for the bolts of the blade causal for the accident were different;
34) No material defects were found that could have caused the crack of the blade.

3.2. Causes of the accident

During the investigation, PKBWL determined that the cause of the accident was the inflight separation of one of the gyroplane main rotor blades.

Contributing factors:

1) **Operation of the main rotor blades having long unknown operation time;**
2) **Incorrect maintenance of the gyroplane;**
3) **No pre-flight inspection on the day of the accident;**
4) **The design of the rotor blade connector, which contributed to the concentration of stresses inside the assembly part of the blades, which has an adverse impact on the fatigue durability of the main rotor blades and, in case of errors in the maintenance of the rotor, accelerates the destruction of the blade internal structure.**

4. SAFETY RECOMMENDATIONS

4.1. Ad hoc recommendations

As a result of the accident in question, at the request of the State Commission on Aircraft Accidents Investigation, 25 November 2019, the President of the Civil Aviation Authority issued the Airworthiness Directive No. SP-0004-2019-A concerning the duralumin main rotor blades manufactured by the Aviation Artur Trendak and Cellier Aviation companies, installed on the gyroplanes (Annex No 1 to the Draft Final Report).

4.2. Safety recommendations issued after the accident investigation

Z-1/2019/5260

The investigation of the incident showed that the hub design of the ZEN1 gyroplane, particularly the connector of the main rotor blades, require improvement.

Accordingly, the PKBWL recommends:

The manufacturer of the ZEN1 gyroplane, in coordination with the Civil Aviation Authority, will implement the design changes to reduce the bending moment acting on the blades.

Z-2/2019/5260

The Airworthiness Directive No SP-0004-2019-A, issued by the President of the Civil Aviation Authority 25 November 2019, defines corrective actions until the investigation of this accident is completed by PKBWL.

Accordingly, the PKBWL recommends:

The manufacturer of the ZEN1 gyroplane, in coordination with the Civil Aviation Authority, will limit the service life of all duralumin main rotor blades manufactured by Aviation Artur Trendak and Cellier Aviation installed on gyroplanes to 1000FH until the implementation of Recommendation No Z-1/2019/5260.

5. APPENDICES

- Airworthiness Directive Nr SP-0004-2019-A.

THE END

Investigator in Charge

.....

RZECZPOSPOLITA POLSKA
URZĄD LOTNICTWA CYWILNEGO

REPUBLIC OF POLAND
CIVIL AVIATION AUTHORITY

ul. Marcina Flisa 2 02-247 Warszawa, Tel. (4822) 520 73 36, Fax. (4822) 520 73 73

Warszawa, dn.25.11.2019 r.
Warsaw, day/month/year

DYREKTYWA ZDATNOŚCI - AIRWORTHINESS DIRECTIVE
Nr SP-0004-2019-A

1. **Przedmiot** (*wyrób/ model, wyposażenie, numery*): **Wiatrakowce wyposażone w duralowe komplety łopat produkcji firm Aviation Artur Trendak lub Cellier Aviation** objęte ewidencją lub rejestrem cywilnych statków powietrznych, prowadzoną przez Prezesa Urzędu Lotnictwa Cywilnego oraz ewidencją lub rejestrem obcego państwa.

   ***Subject** (product / model, equipment, numbers): **Gyroplane with installed duraluminium main rotor blades made by Aviation Artur Trendak Company** or **Cellier Aviation Company** entered in the record or register of civil aircraft managed by the President of the Civil Aviation Authority or a foreign state record or register.*

2. **Numer Świadectwa Typu /Orzeczenia (**Nazwa Nadzoru**):** Pozwolenia na wykonywanie lotów w kategorii - Ultralekki statek powietrzny lub w kategorii specjalnej.
   ***Certificate / Type Certificate Number** (Authority): Permit to Fly for Very Light Airplane or Special Category.*

3. **Dotyczy** (opis usterki, rysunek części): Ułamania łopaty wirnika nośnego wiatrakowca podczas lotu.
   ***Applies** (description of the defect, part's drawing): Break of the main rotor blade during flight.*

4. **Przyczyna wydania** (*dla wyrobów importowanych przywołać AD Nadzoru Lotniczego kraju producenta*)**:**

   Podczas wykonywania lotu na wiatrakowcu ZEN 1/ TERCEL doszło do sytuacji awaryjnej z powodu ułamania się duralowej łopaty wirnika nośnego. Badanie przyczyny wypadku lotniczego prowadzone jest przez Państwową Komisję Badania Wypadków Lotniczych (PKBWL). W związku z zaistniałym wypadkiem lotniczym wprowadza się działania korygujące określone w pkt. 5 niniejszej Dyrektywy Zdatności.

   Ze względu na możliwość zastosowania duralowych łopat wirnika nośnego produkcji firm **Aviation Artur Trendak lub Cellier Aviation** (o zbliżonej konstrukcji i technologii produkcji) na innych typach wiatrakowców, postanawia się wszystkie te łopaty objąć zaleceniami niniejszej dyrektywy zdatności.

   ***Reason for issuing** (for imported products, refer to CAA's AD of the State of manufacturer):*

   During operation of gyroplane ZEN 1/TERCEL one of duraluminium main rotor blade broke.

   This accident is under investigation provided by Polish State Investigation Committee.

   With reference to the above, the following corrective actions, as specified in point 5 of this Airworthiness Directive, are introduced.

   *Taking into account possibility of installing of such duraluminium main rotor blades made by **Aviation Artur Trendak** or **Cellier Aviation companies** (with similar design and production technology) on others gyroplanes it is also decided to make such blades subject to the provisions of this airworthiness directive.*

5. **Działania korygujące** (*dla wyrobów importowanych wpisać „jak w AD" pkt. 6*)**:**

   Nakazuje się wszystkim właścicielom / użytkownikom wiatrakowców z zabudowanymi duralowymi łopatami WN produkcji firm **Aviation Artur Trendak lub Cellier Aviation:**

   1. Łopaty z nalotem do 1000 godz. - dokonać przeglądu łopat WN przed pierwszym lotem oraz co 25 godz. lotu zgodnie z obowiązkowym biuletynem firmy Trendak Nr 01-19 zawartym na stronie internetowej

Aviation Artur Trendak w zakładce „Do pobrania" – „Biuletyny Serwisowe" – „Biuletyn Serwisowy-Rotor".

Podczas przeglądu nasadowej części łopaty (po dokładnym umyciu i przy użyciu lupy powiększającej x5 lub x10) szczególną uwagę zwrócić należy na wszystkiego rodzaju uszkodzenia, a w szczególności pęknięcia. Dodatkowo wykonać sprawdzenie na obecność pęknięć nasadowej części łopaty metodą penetracyjną podaną w pkt. 6 w/w biuletynu.

Wszystkie łopaty ze stwierdzonymi lub podejrzanymi uszkodzeniami powinny być wycofane z eksploatacji do oceny przez uprawnionych specjalistów/organizacje.

Demontaż i montaż łopat wykonywać zgodnie z instrukcją obsługi technicznej w/w firm.

2. Łopaty z nalotem powyżej 1000 godz. wycofuje się tymczasowo z eksploatacji do czasu zakończenia badania wypadku lotniczego przez Państwową Komisję Badania Wypadków Lotniczych.

Corrective actions *(for imported products enter "as in AD" point 6):*

All owners / operators of gyroplanes with installed duraluminium main rotor blades made by Aviation Artur Trendak or Cellier Aviation Companies are required to perform the following actions:

1) *The blades with flight hours less than 1000 (one thousand) hours - Inspect blades before the first flight and every 25 hours flight in accordance with the* ***01-19 Trendak Mandatory Service Bulletin*** *shown on internet web side "Aviation Artur Trendak" –"Dowload"- "Service bulletins"- "Biuletyn Serwisowy –Rotor". During inspection of the root part of the blade (after thorough washing and using a magnifying glass x5or x10), special attention should be paid to all types of damage, in particular cracks. Additional perform a dye penetrant inspection of the root part of the blade according to point 6 m/a bulletin.*
All blades with identified or suspected damages should be withdrawn from operation for assessment by authorized specialists / organizations.
Disassembly and assembly of main rotor blades should be done according to Maintenance Manual issued by m/a companies.

2) *The blades with flight hours more than 1000 (one thousand) hours temporarily should be withdraw from operation until the end of the accident investigation by Polish State Investigation Committee.*

6. Corrective actions *(for imported products „as in AD" para. 6)*:

Name of Aviation Authority issuing the AD *(for foreign AD state the reference and date of issue)*: **N/A**

7. Dokumentacja związana *(Biuletyn Obowiązkowy)*: **Obowiązkowy biuletyn serwisowy Nr 01-19**

Ref. publications *(Mandatory Bulletin): Trendak Mandatory Service bulletin 01-19.*

Niniejsza Dyrektywa Obowiązuje z dniem: Z dniem ogłoszenia.
/ Effectivity date of this AD: *(day/month/year): / The day of publication*

Dyrektor
Departamentu Techniki Lotniczej
Director
Aviation Technical Department

DYREKTOR
Departamentu Techniki Lotniczej

Andrzej Kotwica

URZĄD LOTNICTWA CYWILNEGO
DEPARTAMENT TECHNIKI LOTNICZEJ
ul. Marcina Flisa 2 02-247 Warszawa, Tel. (4822) 520 73 36, Fax. (4822) 520 73 73

Warszawa, dn. 25.11.2019 r.

ULC/LTT-3/0004/2019/AD

Według rozdzielnika

Dotyczy: Wydania Dyrektywy Zdatności

Concerns: *The issuance of the Airworthiness Directive*

Zatwierdzam i wprowadzam, jako obowiązującą z chwilą otrzymania **Dyrektywę Zdatności Nr SP-0004-2019-A** z dnia 25.11.2019 r.

I approve and introduce, as mandatory when received, the ***Airworthiness Directive No. SP-0004-2019-A*** *of November 25.11.2019*

Dyrektywa Zdatności dotyczy: wszystkich wiatrakowców z zabudowanymi duralowymi łopatami wirnika nośnego produkcji firm **Aviation Artur Trendak lub Cellier Aviation.**

The airworthiness directive applies to:

Gyroplane with installed duraluminium main rotor blades produced by Aviation Artur Trendak Company or Cellier Aviation Company entered in the record or register of civil aircraft managed by the President of the Civil Aviation Authority or a foreign state record or register.

Przyczyna wprowadzenia Dyrektywy Zdatności:
Ułamanie się łopaty wirnika nośnego w locie.

Applies *(description of the defect, part's drawing):*
During operation of gyroplane ZEN 1/TERCEL one of duraluminium main rotor blade broke.

Niniejszym informujemy wszystkich użytkowników i właścicieli tych wiatrakowców o obowiązku zastosowania się do wymagań podanych w pkt. 5. Dyrektywy Zdatności SP-0004-2019-A.

We hereby inform all users of these gyroplanes about the obligation to comply with the recommendations and corrective actions stated in Airworthiness Directive SP-0004-2019-A point. 5.

Załączniki: 1. Dyrektywa Zdatności AD Nr SP-0004-2019-A.

Enclosures 1: Airworthiness Directive SP-0004-2019-A

Dyrektor
Departamentu Techniki Lotniczej

DYREKTOR
Departamentu Techniki Lotniczej

Andrzej Kotwica

Rozdzielnik:
Producenci łopat WN : - Aviation Artur Trendak
- ARGO Aero

Komórki organizacyjne ULC: - LBB
- LTT-2
- LTT-3
- LTT-4.

Państwowa Komisja Badania Wypadków Lotniczych (PKBWL)