



FINAL REPORT

OF CIVIL AVIATION SAFETY INVESTIGATION

CLASSIFICATION: Accident

Owner: Private

Operator: Private

Aircraft: IKARUS C22

Manufacturer: Comco Ikarus GmbH - Germany

Registration country: Romania

Registration: YR - 5071

Location: Area of Copalnic Mănăştur locality
Maramureş County

Date and time: 23.08.2014 / 18:30 LT (15:30 UTC)



No. A 17- 11

Date: 18.09.2017



ACKNOWLEDGEMENT

This REPORT presents data, analysis, conclusions and recommendations on civil aviation safety, of the Civil Aviation Safety Investigation Commission appointed by the General Director of CIAS.

The flight safety investigation was conducted in accordance with the provisions of the *Government Ordinance No. 51/1999 concerning the technical investigation of civil aviation accidents and incidents, approved with amendments and additions by Law No. 794/2001, of the REGULATION (EU) No. 996/2010 of the European Parliament and of the Council from 20 October 2010 on the investigation and prevention of accidents and incidents occurred in civil aviation and repealing of Directive 94/56/EC and the provisions of Annex 13 to the Convention on International Civil Aviation signed at Chicago on 7 December 1944.*

The objective of civil aviation safety investigation is preventing the occurrence of accidents and incidents, by effective determination of causes and circumstances that led to this occurrence and establishing the necessary recommendations for civil aviation safety and it HAS NOT THE PURPOSE of finding guilty, individual or collective responsibilities.

As a consequence, the use of this REPORT for other purposes than preventing the occurrence of accidents and incidents might generate misinterpretations.



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SYNOPSIS

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Accident

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Comco Ikarus GmbH Germany

IKARUS C22

Romania

YR-5071

Copalnic Mănăştur

23.08.2014 / 18:30 LT (15:30 UTC)

On 23.08.2014, the ultralight aircraft IKARUS C22 type, identified YR-5071, performed private flights consisting of flying laps around the airfield in the proximity of Copalnic-Mănăştur village, Maramureş County.

During the last flight of the day, with take-off at around 18:15 LT, while on the glideslope, the aircraft entered in a strong dive, had a recovery gaining height, after which it followed a new pronounced dive till the rough contact with the ground. After the ground impact, the aircraft was totally destroyed, the pilot died, and the passenger suffered multiple injuries requiring hospitalization.

The probable cause of this accident is the elevator loss of control due to the detachment of attaching bolt from the rear end of the control transmission rod to the elevator with elevator pushrod, causing the loss of control in flight.

The accident was notified in written to CIAS, being registered with no. 0678/2014.

The flight safety investigation was conducted in accordance with the provisions of the Government Ordinance No. 51/1999 concerning the technical investigation of civil aviation accidents and incidents, approved with amendments and additions by Law No. 794/2001, of the REGULATION (EU) No. 996/2010 of the European Parliament and of the Council from 20 October 2010 on the investigation and prevention of accidents and incidents occurred in civil aviation and repealing of Directive 94/56/EC and the provisions of Annex 13 to the Convention on International Civil Aviation signed at Chicago on 7 December 1944.

1 FACTUAL INFORMATION

1.1 History of accident

During the morning of 23.08.2014, the owner of IKARUS C22 aircraft, registered YR-5071, informed the administrator of a flight field from the area of Copalnic-Mănăştur village that he intended to perform private flights along with a licensed pilot.

After arriving to flight field, the owner took the aircraft out of the hangar and positioned it in order to start the flight activity. The pilot also arrived to the flight field and performed a technical inspection before the flight. According to the witnesses' statements, the inspection was especially concentrated on checking the engine operation.

The flight activity lasted almost two hours, consisting of more flying laps with different passengers, the pilot occupying the pilotage seat on the left. During the last flight, the aircraft owner, who was not a licensed pilot, occupied the pilotage seat on the left, and the pilot occupied the pilotage seat on the right. During landing procedure, while the aircraft was on the third side of the lap, the owner (who was at the aircraft command) noticed the elevator loss of control.

The pilot took over the aircraft controls and tried to control the flight using only the engine thrust and elevator trimmer.

The aircraft continued the lap, and on the landing slope it entered in a strong dive, had of recovery with gain of height, after which it followed a new pronounced dive. Due to the height of the aircraft, the pilot no longer had the necessary time to control the aircraft evolution and collided the ground at a pronounced diving angle (approx. 70° - 80°).

The accident occurred at 18:30 LT.

The accident site coordinates are:

Latitude: 47°30'46.0" N;

Longitude: 23°40'10.0" E.



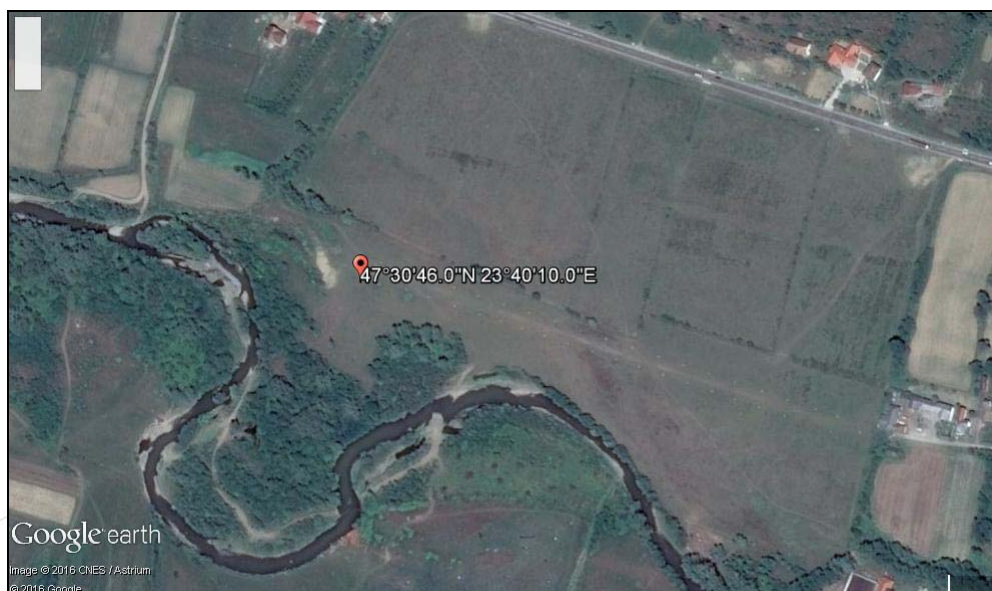


Fig. 1 – Accident site

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	-	-
Serious	-	1	-
Minor	-	-	-
None	-	-	-
TOTAL	1	1	-

1.3 Damage to aircraft

The aircraft was totally destroyed.



Fig. 2 Aircraft wreckage

ANALIZĂ PENTRU SIGURANȚA
VILE (CIAS)



1.4 Other damage

N/A.

1.5 Personnel information

Pilot	Male, 63 years old
License	Motorized Ultralight Aircraft Pilot License, valid until 08.04.2016
Medical certificate	Class 1/2/LAPL, valid until 20.03.2015
Flight experience	4171 hours, out of which 396 hours on ULM

The motorized ultralight aircraft pilot license was obtained on 13.05.2003. Until 24.04.2014, he also had the quality of pilot instructor. In the past the pilot also had a commercial pilot license – for airplanes with a maximum weight of 2300 kg, equipped with a single engine piston, as well as glider pilot license, both valid until 22.10.2001.

1.6 Aircraft information

According to the Annex of Identification Certificate the aircraft was not certified, authorized to be used, in conformity with the law in force, exclusively by the owner in his own interest, for private flights, school flights for the owner's qualification, as well as technical flights.



Fig. 3 Ikarus C22 YR-5071 aircraft

Manufacturer and aircraft type	Comco Ikarus GmbH-Germany, Ikarus C22
Series number and manufacturing year	9107-3342, 1991
Registration state and mark	Romania, YR-5071
Owner	Private
Owner (Operator)	Private
Identification Certificate	No. 0124, issued on 17.03.2014
Total number of hours	760 h 34 min (May 1 st , 2014)

Ikarus C22 is an ultralight monoplane airplane of mixed construction, duraluminium and Tedlar with strengthening elements of steel alloy, with strutted wing. The wings, "thin" profile are provided with trapezoidal ailerons.

Horizontal empennage: a fixed plan and a mobile one equipped with trimmer. Vertical empennage: a fixed plan and a mobile one. The fuselage is made on a dural tube of large diameter, on which the engine is mounted on the front side, and the empennage on the rear side. The tricycle landing gear, with airplane nose wheel.

The cockpit has two seats, side-by-side and is situated behind and under the engine. The cockpit is reinforced by two tubular frames of alloy steel pipe, with composite material cowling, on which there are fixed the access doors, windshield and the panel behind the seats. Behind the seats there are two tanks of gasoline of 25 liters each (there can be installed maximum 2 pieces x 30 liters).

Controls: stick, gas throttle, wheel brake manually controlled, trimmer.

The aircraft is equipped with a ROTAX 582 engine with two timed cylinders, electronic ignition, water cooling, with WARP DRIVE propeller, of composite material, quadri-blade, with ground adjustment.

This aircraft type is provided with rescue system (special parachute). For YR-5071 aircraft this system was declared inoperative.

According to the records in the aircraft logbook:

- the last record at chapter "*Flight activities*", on May 1st, 2014, shows that the engine installed on the aircraft had 129 h 30 min of operation;
- the last record at chapter "*Maintenance works and repairs*" is dated January 9, 2014 and mentions "*Checked the aircraft, engine and propeller for flight*".



Elevator control assembly

The elevator control assembly is made of:

- Stick assembly (1)
- Transmission rod (2)
- Elevator control pushrod (3)

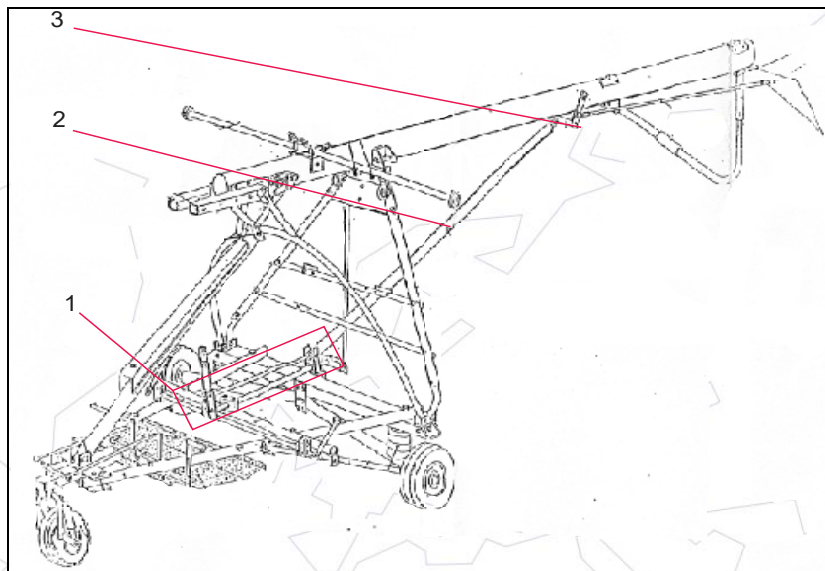
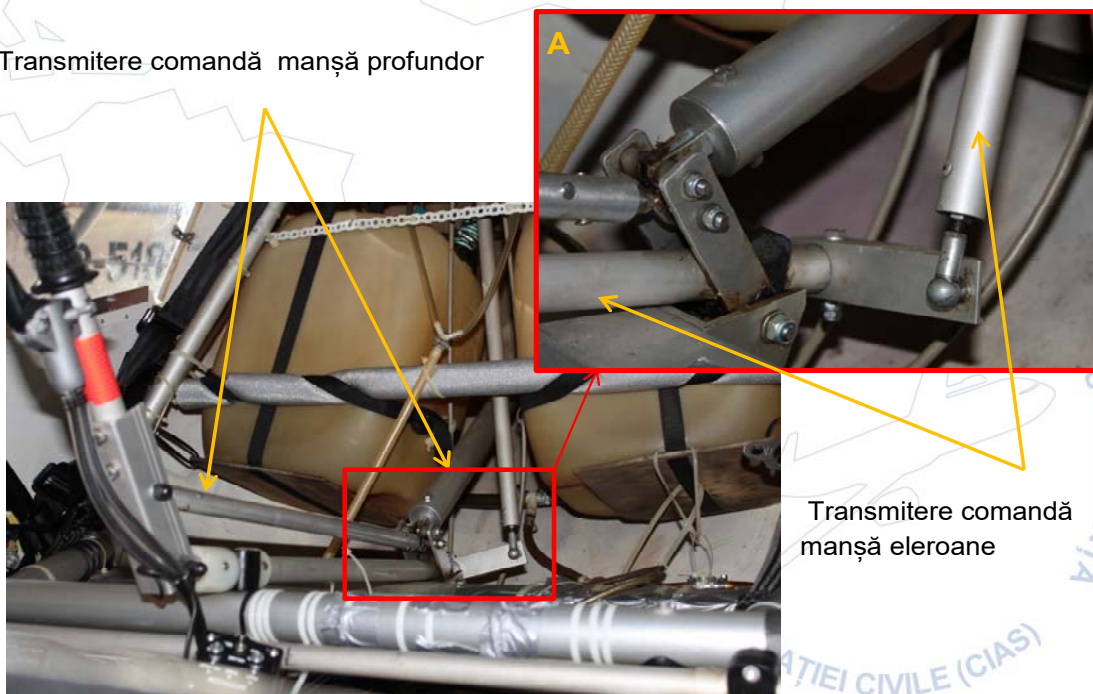


Fig. 4 Elevator control chain

The stick assembly sends commands to the elevator and to the ailerons, as follows:

Transmitere comandă manşă profundor



Transmitere comandă
manşă eleroane

Fig.5 Transmission of stick-elevator and stick ailerons command



To send the command to the elevator, the transmission rod is connected to the front end with the stick assembly through the attaching rod end assembly.

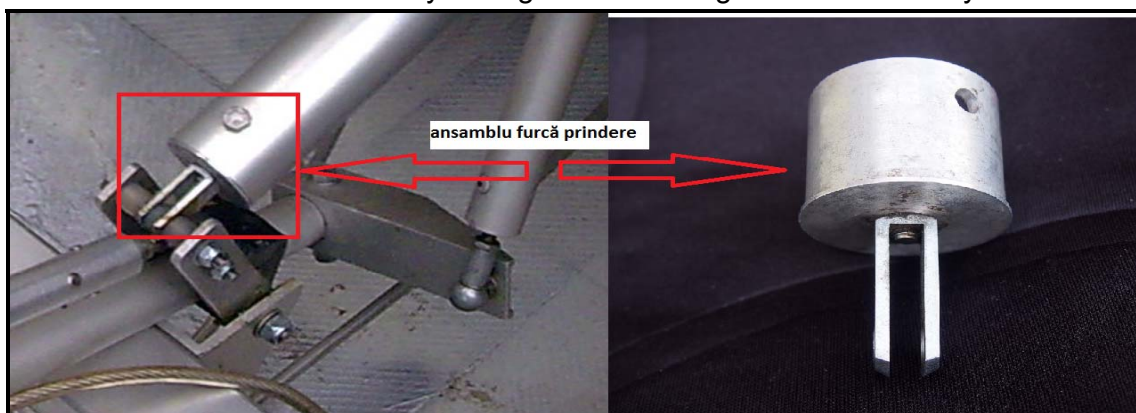


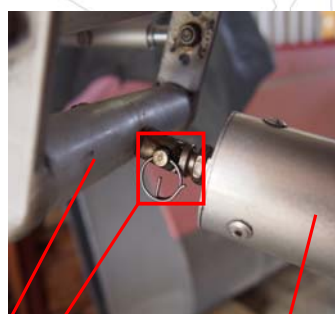
Fig. 6 Attaching rod end assembly

At the rear end, the connecting rod is linked to the elevator pushrod through a bolt that is secured by a safety ring.



connecting rod

elevator control lever



connecting rod



bolt+safety ring to attach the connecting rod with elevator control lever

Fig. 7 Connecting rod and elevator pushrod – connecting chain

1.7 Meteorological information

The weather conditions had no influence on the occurrence of this accident.

1.8 Aids to navigation

N/A.

1.9 Communications

N/A.

1.10 Flight field data

The airfield in the proximity of Copalnic Mănăştur locality, the one that the last take-off was made from, correspond, according to Romanian Government Decision no. 912 from 25.08.2010, to other fields than the certified aerodromes from/on which civil aircraft can perform take-offs and landings.

It is organized on a field covered with lucerne, with dimensions of 400 x 25 m, oriented on 120° - 300° directions. The working field has the peculiarity that on 300° direction, it has a slight descending slope, followed by a more pronounced slope, given by the profile descending hills to a railway, which provides optimum conditions for take-off/landing from/on this field.

1.11 Flight recorders

This aircraft type is not provided with flight recorders.

1.12 Wreckage and impact information

After the ground impact, which occurred on a pronounced dive angle (almost 70° - 80°), the aircraft was totally destroyed.



Fig. 8 Impact site



1.13 Medical and pathological information

The forensic report revealed that the pilot's death was violent due to internal bleeding through rupture of the ascending aorta and myocardial injury in a polytrauma through aviation accident (hitting from rough plans inside the aircraft). The passenger suffered multiple injuries requiring hospitalization.

1.14 Fire

After the impact the aircraft did not caught fire.

1.15 Survival information

On 23.08.2014, at 18:30 o'clock, I.S.U. Maramureş was announced by phone call about an aviation accident on the airfield close to Copalnic Mănăştur locality. Mobile intensive care teams and first aid within S.M.U.R.D Baia Mare traveled to the accident site, also a firefighting truck belonging to the Volunteer Emergency Service in the locality. Two victims were found at the accident site.

The personnel of SMURD gave the first aid, namely attempted to resurrect one of the victims, who unfortunately died. The other victim presented multiple traumas and was transported by SMURD team at Baia Mare hospital for medical care.

1.16 Tests and research

Considering the witnesses' statements on the aircraft evolution, the passenger's statement and based on a video recording of the accident, the investigation commission identified as possible cause of the accident, problems in the elevator control chain operation, therefore this was carefully analyzed.

A first examination of the aircraft elevator control chain components show that the connecting rod between the stick and the elevator control lever shows, after the accident, different deformations on its two ends: while a rupture appeared at the front end of connecting rod (the two arms of the attaching rod end assembly are broken from their attaching element in the transmission rod) (fig. 9), the attaching element situated on the rear end of the rod, as well as the attaching element of the elevator control lever, do not have any deformations due to impact (fig. 10).





a

b

Fig. 9 Front end of connecting rod



Fig. 10 Rear end of connecting rod and elevator control lever

It was performed a metallurgical analysis of a component in the aircraft elevator control chain, called the *attaching rod end assembly* (see fig. 11), situated at the rear end of the main control rod, in order to determine the causes of the rupture occurred at the front end of connecting rod.



Fig. 11 Attaching rod end assembly – new component



The metallurgical analysis was performed starting from the study of broken/damage component (Fig.14), considering its montage and operation position, according to the image of attaching rod end assembly in the elevator control chain, as well as according to the detailed images, after demounting the component (Fig. 12 and Fig. 13).



Fig.12 Arm 1

Arm 2

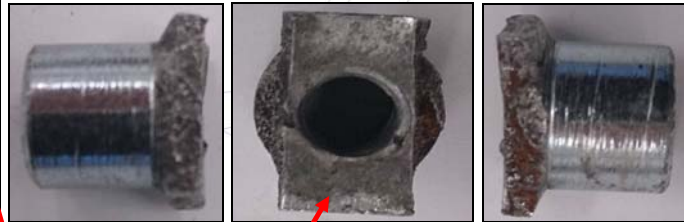


Fig.13 Attaching rod end element



Fig. 14 Attaching rod end assembly

From the presented images it can be noticed the following:

1. the montage position of the attaching rod end assembly was asymmetrical, the four positioning spacers being installed only three, respectively one, on each side of its arms;
2. roundness of a single articular hole, practiced in the shipper arms (see Fig 12, arm 1);
3. deformation of a single hole caused by the rod end attaching axis in the control chain, in front of the arm minimum section (see Arm 1 in Fig. 12);
4. the arms rupture surfaces have a degree of asymmetry and a different morphology, as follows:

- a) Arm 1 presents on the rupture surface rust traces, presenting both smooth and rough areas, characteristic of a fatigue rupture;
 - b) Arm 2 presents a rupture surface without rust traces, with a relatively uniform harsh aspect, characteristic of a sudden rupture;
5. the surface of rod end attaching element shows a shiny aspect, as a result of operating friction with the following component of the control chain, made of an alloy of Al, directly coming in contact with;
 6. the hole of the rod end attaching axis from the Al alloy is not deformed.

The performed metallurgical analyzes show the following:

1. After the macroscopic analysis of the component called attaching rod end assembly, from the elevator control chain, show that it functioned asymmetrically, due to montage position, being stressed in an unbalanced way to forces and torques that led to the accumulation of uneven tensions in the two arms, causing its rupture;
2. The two arms of the attaching rod end broke, **one of them breaking due to fatigue (arm 1)**, and the other one not being sized to integrally take-over the operating stresses, given the asymmetrical montage / operation conditions, **suddenly breaking (arm 2)**;
3. As a result of operating stresses, the attaching rod end broke in the area where, on one side the section was minimum, and on the other side where there have accumulated the most of tensions due to its manufacturing;
4. The component sizing was calculated to the limit, the improper steel structure (rows structure) contributing to rupture, by decreasing the nominal values taken into account by the designer for that steel class;
5. The proper structure for such steel should have been a normalization one, with fine and uniform grains;

The metallurgical analysis conclusion is that the incorrect (asymmetrical) montage of the attaching rod end assembly caused the rupture of arm no. 1 in time (fatigue rupture), but arm no. 2 suddenly broke (most likely at the aircraft impact with the ground).

1.17 Management and organizational information

The flights dated 23.08.2014 were performed on an airfield in the vicinity of Copalnic Mănăştur locality, which, according to the provisions of the Romanian Government Decision no. 912 from 25.08.2010, correspond to other fields than the certified aerodromes from/on which there can be performed take-offs and landings of civil aircraft.



In such situations, the flight activity is regulated by RACR-CCO ULM, chapter 5 "Requirements on the operation/use of ULM aircraft":

RACR-CCO ULM 1195 – Flight Rules

The operation/use of ULM aircraft can be performed only by the Visual Flight Rules (VFR) on daytime, in accordance with the provisions of RACR-RA (Air Rules), of the Air Code, as well as with the provisions of the other specific regulations applicable in the field of civil aeronautics with motorized ultralight aircraft.

RACR-CCO ULM 1200 – Uncertified ULM aircraft

The uncertified ULM aircraft can be operated/used only if they have an identification certificate, having written in the Annex, where applicable, the flights categories for which they are authorized. They can perform the following flight categories:

- (1) flights in their own interest;*
- (2) particular flights;*
- (3) technical flights for certification;*
- (4) technical flights to elaborate the flight and maintenance manual (if it doesn't exist or doesn't have a content as provided in Annex 2);*
- (5) notwithstanding those mentioned above, an uncertified ULM aircraft can be used/operated for school flights for qualification in the respective class of aircraft, but only if the student is also the owner of this aircraft.*

Note:

- (1) The uncertified aircraft shall be used/operated only by the pilots qualified for the respective class of aircraft.*
- (2) The transport of passengers is forbidden.*
- (3) Any other person, onboard of the aircraft, beside the qualified pilot and the student pilot for the respective class of aircraft, is considered, according to this regulation, passenger and then Note (2) is applicable.*
- (4) The uncertified aircraft shall wear an inscription mentioning "This aircraft is uncertified", which shall be put in a visible place so that it can be read by users/operators.*



2 ANALYSIS

After the accident occurrence, the two ends of the connecting rods between the stick assembly and the elevator control lever were found as follows:

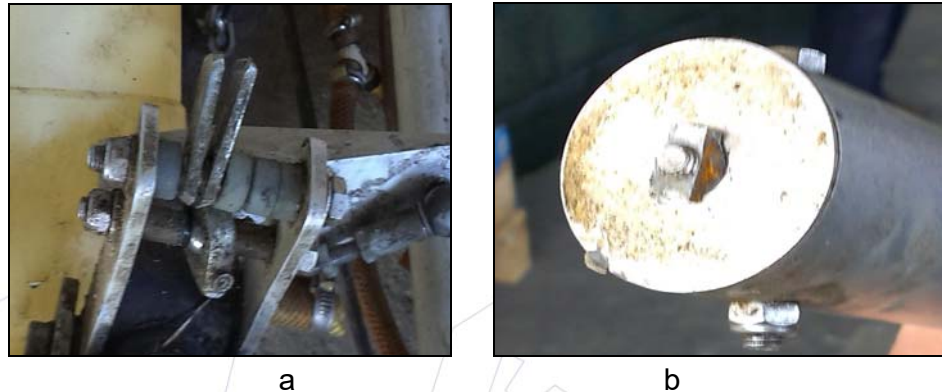


Fig. 15 Front end of connecting rod

In case of the front end of connecting rod (figure 15), the two arms of the rod end assembly (detail a) are detached (broken) from its attaching element (detail b).

After the performed metallurgical analyzes, the investigation commission considers that the incorrect (asymmetrical) montage of the attaching rod end assembly did not influence the accident from 23.08.2014. As a result of the incorrect montage position and the operating stresses, its operation was asymmetrical, and in time it led to the rupture of an arm of the attaching rod end assembly, in such way that the operation of the elevator control chain was provided only by one arm of the attaching rod end assembly.

The command transmission from stick to the elevator functioned, but the failure to correct this defect could have led to the rupture of the second arm and, thus, to the elevator control loss

The attaching element situated at the rod rear end, as well as the attaching element of the elevator control lever, show no deformations resulting from the impact (see figure 16).

By analyzing condition in which these components have been found after the accident, it can be concluded that, while the front of transmission rod was attached to the stick assembly, the rear end and the elevator control lever were not connected, the attaching bolt of the two elements not being present, most likely detaching before the accident.



Fig. 16 Connecting rod rear end and elevator control lever

Many probable causes can be taken into account in leading to the detachment of the attaching bolt between the connecting rod and the elevator control lever.

The investigation commission considered that the most likely the bolt safety ring detached due to vibrations during flight.

This detachment could have been also favored by the bolt operation wear (respectively of the hole destined for the attachment of safety ring), as well as by the loss of calibration of the safety ring respectively the size of the distance between the safety spires – see figure 17 b).

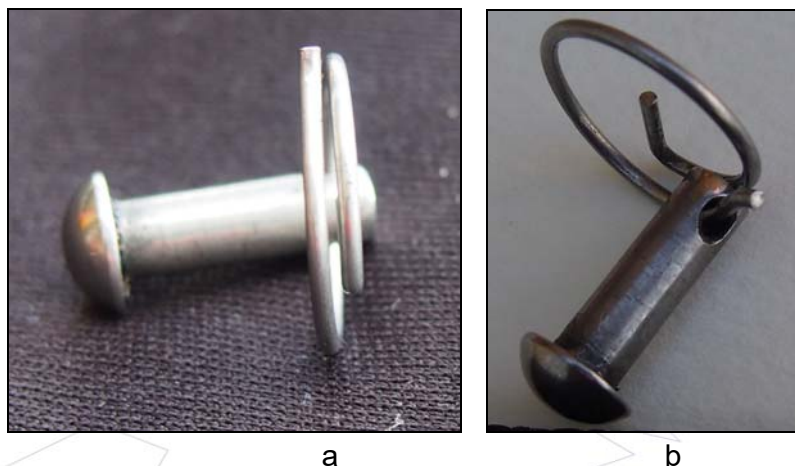


Fig. 17 Safety ring distance

- detail a – new bolt, new ring (correct distance between spires)
- detail b – used bolt and hole, used ring (increased distance between spires, possibility of detaching)

To observe the differences between a bolt without wear and a bolt that was subject to wear appearing after prolonged operation on aircraft, in the figures below there are presented a bolt without wear and a few attaching bolts used on YR-5071 aircraft, removed after the accident .

Because in the logbook of YR-5071 aircraft there are not mentioned any attaching bolts replacements that would have been performed during different maintenance works, it can be assumed that the bolts mounted on the aircraft involved in the accident have the same usage duration, this including also the bolt that should have been mounted to connect the control rod with the elevator control lever.



Fig. 18 Unused attaching bolt



Fig. 19 The attaching bolts used on YR-5071

Analyzing the information from this accident through the ULM legislation in force, the investigation commission concluded that a person who doesn't have ULM pilot license, who therefore doesn't have the necessary knowledge to assess correctly the technical condition of the aircraft he's buying, is exposed to a high risk factor. As arguments to support this conclusion we present the following:

- The commission found that it was intervened in the aircraft control chain, and the performed work was incorrect, which resulted in the failure of one of the attaching rod end arms. The commission could not establish when, how and who performed this operation, considering that in the aircraft logbook is wasn't written such an activity, and the owner did not have the necessary qualification and knowledge to determine this nonconformity;
- When changing the owner, according to the provisions of RACR-CCO ULM, the responsible authority appoints an inspector who shall perform only an assessment of documents and a ground checking of aircraft. In the commission's opinion, the fact that these verifications are not followed by a technical flight leads to an incomplete technical checking. It should be highlighted that it was considered the situation in which the new owner, not being a licensed pilot, does not have the necessary knowledge to perform such a verification. The legislation does not provide for such situations to whom may address the new owner and under what legal conditions can be perform such verification;



- In case of uncertified aircraft, but it can also be extended to the certified ones, the aircraft maintenance manual is very general, it does not provide step by step how certain operations should be performed. For example, it is specified that it should be checked the control chain. Such an operation can assume only a visual check, and not a close analysis of each component piece, so it all depends on the owner's level of knowledge and experience.
- Considering that the pilot owning the valid motorized ultralight aircraft pilot license didn't claim his instructor quality, practically the owner was found in the position of passenger and shouldn't have been on board of the aircraft, according to RACR-CCO ULM 1200. It was the pilot's duty to deny the embarking of any passenger.

Thus, the investigation commission considers that it is imposed for the responsible authority in the field to find new solutions, to complete the legislation in force, so that all the aircraft, when issuing an identification certificate accompanied by an annex, to be thoroughly checked, including in flight and to pay more attention to the content of maintenance manual.

Standard equipment for Ikarus C22 aircraft includes a rescue system, however for YR-5071 aircraft this system was inoperative. If the rescue system was operational, there would have been a chance that this accident could have had much less consequences.

3 CONCLUSIONS

3.1 Findings

The investigation commission of the accident from 23.08.2014, involving the ultralight aircraft, Ikarus C22 type, registered YR-5071, operated by a private owner, found the following:

1. The aircraft was not certified in Romania and it was not placarded according to the requirements of RACR-CCO ULM 1200 note (4);
2. After the assessment made by the certification authority, it was identified and it was issued its annex specifying that it can be used to perform flights in his own interest, private flights, school flights to qualify the owner;
3. In the YR-5071 operation and maintenance manual that has been submitted to the certification authority in order to identify this aircraft, it is stated "*The aircraft does not have a functional rescue system*";
4. The flights performed on 24.08.2014 did not take place according to the provisions of RACR-CCO ULM, chapter 5 "*Requirements on the operation/usage of ULM aircraft*";
5. The aircraft pilot had a valid motorized ultralight aircraft pilot license;



6. Until 24.04.2014, he also had the qualification of pilot instructor; subsequently this qualification was no longer revalidated;
7. The pilot's experience on this aircraft could not have been determined;
8. On the date of the accident, the pilot's medical certificate was valid;
9. During the elevator loss of control, the passenger (aircraft owner) was in control of the aircraft;
10. The aircraft owner had no pilot license;
11. No fire occurred onboard of the aircraft after the impact;
12. In the operation and maintenance manual specific to YR-5071 aircraft, the requirements/indications referring to the scheduled periodical maintenance aren't clearly exposed, but only generally, in the chapter "Storage and maintenance";
13. In the aircraft logbook, the last record on maintenance works is dated 09.01.2014, meaning 7 months before the accident;
14. After examining the elevator control assembly after impact, it was found that:
 - At the front end of transmission rod it occurred a rupture: the 2 attaching rod end assembly arms are broken from their attaching element in the transmission rod;
 - The attaching element situated at the transmission rod rear end, as well as the elevator control lever attaching element, do not show any deformation as the impact result.

3.2 Cause of the accident

The probable cause of the accident is the loss of elevator control due to the detachment of the attaching bolt of the transmission rod rear end to the elevator control lever, resulting in the aircraft loss of control in flight.

4 RECOMMENDATIONS

The investigation commission makes the following safety recommendations:

1. It is recommended to the aircraft manufacturer, COMCO IKARUS GmbH, to amend the operation and maintenance manual of this aircraft type on the mandatory replacement of the attaching bolts safety rings from different aircraft components each time these bolts are removed or to issue an informative bulletin in this respect.



2. It is recommended to the Romanian Aeroclub, as certifying authority, to complete the legislation in force so that, when issuing an identification certificate accompanied by its annex, the aircraft shall be technically checked, including in flight.
3. It is recommended to the Romanian Aeroclub, as certifying authority, to grant an increased attention to the maintenance manual, which shall contain detailed indications referring to periodical maintenance.



Note: The documents and analysis objects used for the issuance of the flight safety investigation Report are confidential and are archived at the Civil Aviation Safety Investigation and Analysis Center, according to legal provisions.

