



Islamic Republic of IRAN

Civil Aviation Organization

Accident Investigation Final Report



State File Number: 940711EPTRB
Type of Occurrence: Accident
Date of Occurrence: October 02th 2015
Place of Occurrence: Bahregan Helipad
Aircraft Type: Agusta A109E
Registration: EP-TRB
Operator: Tara Helicopter Service

Aircraft Accident

Investigation Board

Date of Issue: 28 Jan 2017



Islamic Republic Of Iran
Civil Aviation Organization
Aircraft Accident Investigation Board

Final Report

Basic Information

State File Number: A13940711EPTRB

Type of occurrence: Accident

Date of occurrence: OCT 03th 2015

Place of occurrence: Bahregan Airport NW of Persian Gulf /IR of Iran

Aircraft Model: Agusta A 109E helicopter

Registration: EP-TRB

Operator: TARA Helicopter Service Company

Civil Aviation Organization of I.R. of Iran

(Aircraft Accident Investigation Board)

Mehrabad International Airport

Tehran/Iran

PBO: 13445-1795

Fax: + 98 21 6601 8659

Tel.: + 98 21 6604 7965

<http://www.cao.ir>

E-mail: AIG@cao.ir

Investigator in charge: H-Rezaeifar

Table of contents

Foreword.....	3
Synopsis.....	4
1. Factual Information.....	5
1.1 History of the flight.....	5
1.2 Injuries to persons.....	5
1.3 Damage to helicopter.....	5
1.4 Other damage.....	7
1.5 Personnel information.....	8
1.5.1 Captain.....	8
1.5.2 First officer.....	8
1.6 Helicopter information.....	8
1.7 Meteorological information.....	9
1.8 Aids to navigation.....	9
1.9 Communication.....	9
1.10 Aerodrome information.....	9
1.11 Flight recorders (FDR&VVR).....	9
1.12 Wreckage and impact information.....	10
1.13 Medical and pathological information.....	10
1.14 Fire.....	10
1.15 Survival aspect.....	10
1.16 Test and Research.....	11
2. Analysis.....	12
3. Conclusions.....	12
3.1 Findings.....	12

3.2 Causes.....	13
3.2.1 Main Cause.....	13
3.2.2 Contributing Factors.....	13
4. Safety Recommendations.....	13
5. Appendices.....	

Foreword

In accordance with Annex 13/Doc 9756 IV of the Convention on International Civil Aviation Organization and Iranian civil aviation regulations, The analysis of the accident, conclusions and safety recommendations contained in this report are neither to apportion blame nor to assess individual or collective responsibility, the sole objective is to draw lessons from this occurrence which may help to prevent future accident or serious incidents. Consequently, the use of this report for the purpose other than for the prevention of future accidents could lead to erroneous interpretation.

Synopsis

Date and Time

03 October, 2015

Helicopter

Agusta 109 E. manufacture date 1997

Registration: EP-TRB

Owner and Operator

Tara Helicopter Service Company

Site of Accident

Bahregan Helicopter Base north west of

Persian Gulf

Persons on board

Crew: 2

Accident Main Cause

Human Factors

Type of Flight

Transport passenger from helideck to Bahregan Base

Fatalities & Injuries

None

Damage to Helicopter

Substantial Damage

State File Number

940711

Summary

During the final phase of pre-Takeoff check, the helicopter at full RPM began to bounce up and down and then the right landing wheel sheared and threw away within a few seconds. As soon as the right landing wheel was broken, one of the main rotor blade (the Red blade) hit the tailboom and within a second the helicopter came to the rest on its right L/G (shock strut) and finally got sustained substantial damage.

1. Factual Information

1.1. History of flight

1.1.1 At 09:00 UTC October 03, 2015 (12:30 local time) Tara Helicopter Services Company had deployed one of its helicopter Agusta 109 E to operate offshore non-schedule flight for transportation of passenger from helideck to Bahregan heliport. The helicopter EP-TRB on flight number IRR8381 was planned for operation under Visual Flight Rules (VFR).

1.1.2 At 12:10 the pilot performed the preflight check and then he started the helicopter. He was accompanied by the other flight crew as a first officer of the flight.

At 12:30 local time during the final pre-take off check the flight technician at the front of the helicopter noticed the nose wheel was not aligned forward and the he tried to keep center the wheel while asking the pilot in command (PIC) to lift up the nose wheel. This check took a few minutes while the helicopter was in full RPM and in nose wheel up position it began to shake simultaneously laterally. Immediately afterwards, the lateral shaking motion continued to increase.

The amplified motion continued to increase simultaneously and then the right landing wheel collapsed As soon as the right landing wheel collapsed the red blade of main rotors hit the tail boom and helicopter was out of control at this time and the pilot could not recognized the situation what was happened, so he did not take any action regarding to grab and pull the power levers in order to shut down the engines or lift off the helicopter from the ground.

Shortly afterward the accident occurred and both crew immediately left the helicopter without any physical problem or injures.

1.2 Injuries to persons

Nobody on the helicopter or on the ground was killed or injured.

1.3 Damage to helicopter

- Two main blades were broken, separated from transmission due to impact with tail boom and two others were damaged totally.
- The tail boom was tear down and tail rotor shaft cut

- The nose skin was damaged
- The main transmission was separated and destroyed
- The R/H cockpit windshield was broken



1- Main Transmission



2- Broken Tail Boom



3- The Broken & Cut Tail Rotor Shaft



4- R/H Main Landing Gear

The damages on airframe is suspected as” **Destroyed**” however there are some substantial damages on Cockpit instruments and engines.

1.4 Other damage

None

1.5 Personnel information

1.5.1 Captain

Male: Iranian citizen-60 years

License: Airline Transport Pilot License (H) number 1721 issued on 2006 by I.R.I CAO
Valid until 20.12.2015

Flying Experience: Total flight on all type of Helicopters: 5970 hours,

Flying Experience on type: 2160 hours

1.5.2 First officer:

Male: Iranian citizen-47 years

License: Commercial Pilot License (H) number 4415 issued on 02.06.2015 by I.R.I CAO

Valid until 03 August 2016

Flying Experience: Total flight on all type of Helicopters: 1170 hours

Flying Experience on type: 70 hours

Both pilots could not participate in the Full Motion Simulator recently. A109E Full Flight Simulator is available at Leonardo Training Academy which allows the Normal & emergency procedure to be simulated. The Tara Company has requested participation in this simulator but due involved sanction for Iranian company, this request was rejected.

1.6 Helicopter information:

1.6.1 General information:

Registration: EP-TRB

Aircraft Type: Agusta A109 E helicopter

Characteristic: Twin-engine general purpose helicopter with retractable wheel landing gear

Manufacturer: Agusta S.P.A, Cascina Costa di Samarate (VA), Italy

Manufacture date: 1997

Serial number: 11007

Max takeoff weight: 2,850 kg (6,283 lb)

Operating hours: Airframe Total Time since New: 6894
Since last 400-hours inspection: 71 hours
Since last 200-hours inspection: 71 hours

Operating hours, Engine# 1(left)

Type of Engine: PW 206C (CANADA)
Total Time Since New: 1079 hours
Since last installation: 914 hours
Since last service: 914 hours
Since last periodic check: 1053 hours
Total cycles: 10461
S/N: BC-0518

Operating hours, Engine 2(right)

Type of Engine: PW 206C (CANADA)
Total Time Since New: 6262 hours
Since last installation: 3022 hours
Since last service: 3022 hours
Since last periodic check: 6236 hours
Total cycles: 10461

1.7 Meteorological information

The details of meteorological reports issued are given below:

TIME (UTC)	WINDS	VISIBILITY	CLOUDS	TEMP	PRESSURE
0900	320/00	7500M	NSC	34degC	1013HPA

Meteorological condition did not effect on the accident.

1.8 Aids to navigation: Not Relevant

1.9 Communication: Not Relevant

1.10 Aerodrome information: Not Relevant

1.11 Flight recorders:

The helicopter is categorized lightweight twin-engine helicopter and based to annex 6 of ICAO convention , installation of FDR and CVR is not mandatory. For the A109E Helicopter a kit was developed (CVR/FDR MADRAS L3) and is available upon customer request. The FDR ,CVR were not installed on this helicopter.

1.12 Wreckage and impact information

The helicopter was located in front of the hanger, when it was involved in the accident, one of the main rotor (Red one) been thrown 32M away. The transmission and some part of the helicopter were found around the helicopter.

The detailed examination of the wreckage revealed following:

- The Red Main Rotor blade impacted the tail boom and was found 32 meters from the site of accident in front of the helicopter at 11 o'clock relative to the nose of helicopter.
- The right main landing gear had collapsed outward.
- Tail Rotor blades got shredded & delaminated.
- Tail Boom skin got damaged at a few places.
- Pilot side door damaged and seized.
- Tail fin damaged.
- RH horizontal stabilizer was broken at mid-section.
- MAIN Fairing was broken.
- Pitch link horn of Red MRB was broken.
- The drag dampers of Red, Blue & Yellow MR blades sheared off.
- Tail drive shaft fairing cut at three places.
- Tail Rotor blades badly were damaged.
- A wide hole was created on the tail boom.

1.13 Medical and pathological information:

As soon as the accident was happened both flight crew were taken to the hospital for pathological assessment, testing. And as a result there were not any indication of abnormalities which might have been such a factor in the accident.

1.14 Fire:

There was not past impact fire on the wreckage.

1.15 Survival aspect

Both flight crews immediately left the helicopter without any help and physical problem or injuries.

1.16 Test and Research:

1.16.1 The investigation team has seen some corrosion on the broken pitch links. So the pitch links were delivered to the BEA laboratories for analysis. The design data was sent to the BEA by the manufacturer. Examination of the suspected red pitch links was done and there was no evidence of fatigue stress failure revealed. (Analysis report was attached)



1.16.2 Examination of the right wheel attachment bolt. There was no evidence of wheel's bolt ripped off the shaft before the helicopter began to shake.

2. Analysis:

During towing helicopter from hanger to helipad (front of the hanger) the technician estimated rough towing. During start up, the nose wheel was not straight, so the technician requested from pilot to pick nose up to check Nose wheel. It was checked by the technician for just few seconds while it was nose up position and helicopter was full RPM. Also he made a stroke on the NLG to alight it. This action initiated a ground resonance phenomenon on the helicopter, which resulted in the RH wheel separating from Landing Gear and right body was levered. This phenomenon could lead to the unbalance of main blades and finally the red blade hit the tail boom.

- Helicopter does not have any malfunction, defect or mechanical failure during start and run-up and before accident.
- The pilot did not recognize the initiation of the ground resonance, so he did not take the applicable corrective actions.
- The pilot and co-pilot were qualified and authorized for this flight.
- The ground resonance phenomenon can be simulated in the A109E Full Flight Simulator but the pilots could not attend in to the required simulators.

3. Conclusions

3.1 Findings:

- The last 100-hours inspection was carried out at 6844:35 operating hours and no technical discrepancy was found on the helicopter.
- At the time of the accident, both the mass and center of gravity of the helicopter were within the permitted limits according to the flight manual.
- At the time of the accident, the mass of helicopter was approximately 2543 Kg.
- There are no indications of the pilots suffering from health problems during the accident.
- The pilots of this flight both held the necessary Qualifications.
- An eyewitness observed that the helicopter began to oscillate laterally after the helicopter was lifted while it was getting light on the nose wheel and began to shake rapidly.
- The pilot of this flight carried out pre-take off check and almost was ready for takeoff at the time of accident but they were not focused on the Nose Wheel.
- When the ground resonance occurred, the pilot did not take any corrective action according to the procedures in flight manual.
- The cause of broken of the right wheel shaft of the helicopter was high vibration or high shaking
- The weather was not a contributive factor in the accident.

3.2 Causes

3.2.1 Main cause:

So the main cause of accident is human factors; due to improper action of pilot and flight technician accordingly.

The pilot did not recognized the ground resonance and so he did not take corrective action as a RFM/A109 E, and also he permitted the technician to adjust the nose wheel while the helicopter was in full RPM and ready to take off.

3.2.2 Contributing factors

- Lack of supervision of maintenance and operation director on personnel activities.

4. Safety Recommendations:

Because of this investigation, the CAO Aircraft Accident Investigation Board makes the following recommendations:

To Iranian Civil Aviation Authority:

- ✓ Fully articulated helicopter pilots should be aware and more trained of ground resonance phenomenon on these types of helicopters. More familiarization with ground resonance and also details and emphasis in flight manual should be concerned in the training course of the pilots.
- ✓ Use of Full Motion Simulators is recommended for practicing pilots which represent for critical emergencies on A109E series.

To Italian Investigation Authority:

- The manufacturer should advise the operators of the Agusta helicopters to include the “Caution” outlined in page 2-3-6 of the A109 E flight manual in their safety meetings topics.
- The Manufacturer should be advised to include a notice in Agusta 109 series helicopter maintenance manual for familiarization of the maintenance personnel with the ground resonance phenomenon.
- The manufacturer should stablish a process to give required available services to all operators without effectivity of political problems to enhance safety of the helicopters.

5. Appendices



Technical document

Main rotor pitch links examination Final report

Accident on **03/10/2015**
at **Bahregan Airport (Iran, Islamic Republic of)**
to the **helicopter AGUSTA - A109 - E**
registered **EP-TRB**



Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Foreword

This document and the photographs and technical information contained herein are subject to the laws relating to communication and confidentiality embodied in European Regulation 996 of 20 October 2010.

The conclusions of this document are based on the work undertaken by the BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile). They should not be used to prejudge the final conclusions of the safety investigation.

Contents

Foreword	2
Circumstances	4
Equipment	4
Purpose of the examination	4
Parts as received	5
Fractographic examination, red pitch link	6
Fractographic examination, blue pitch link	8
Fractographic examination, yellow pitch link	10
Scanning Electron Microscope examination – red pitch link	12
Scanning Electron Microscope examination – yellow pitch link	13
Scanning Electron Microscope examination – blue pitch link	14
Metallographic examination of the red pitch link	15
Hardness test	16
Energy dispersive spectrometry (EDS) analysis	17
Corrosion test	18

Circumstances

Type and model of aircraft: AGUSTA - A109 - E
Event: accident

Equipment

Part: red, yellow and blue pitch links
Serial number: -
Date of receipt: 29/01/2016

Purpose of the examination

The objective of the examination was to determine the nature of the red, blue and yellow main rotor pitch links ruptures.

Parts as received



General view of the three pitch links – two upper rods (blue and yellow) are missing

Fractographic examination, red pitch link



Fracture surface of the upper rod end, upper side



Fracture surface of the upper rod end, lower side



Fractographic examination, red pitch link



Side views of the fracture surfaces areas, showing significant plastic deformation

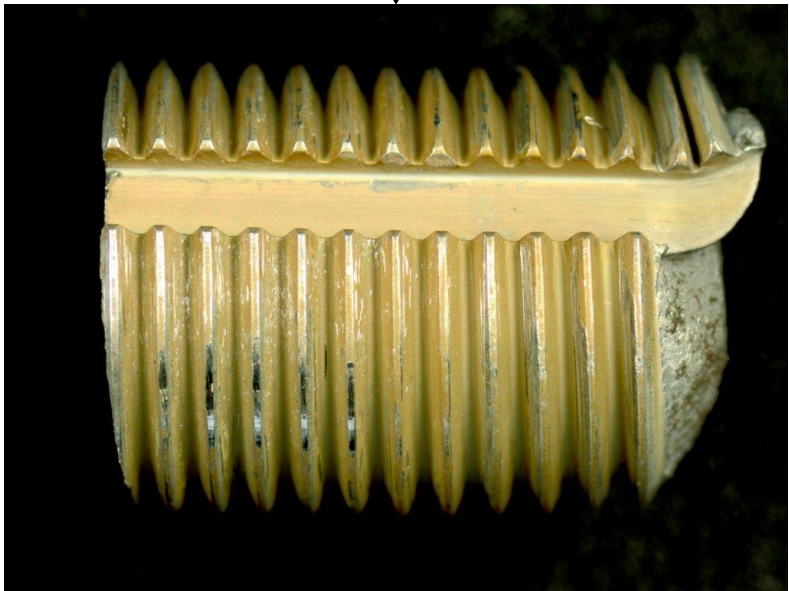
Fractographic examination, blue pitch link



Fracture surface of the upper rod end



Fractographic examination, blue pitch link



Side view of the fracture surface area after cutting of the housing, showing significant plastic deformation

Fractographic examination, yellow pitch link



Fracture surface of the lower rod end



Fractographic examination, yellow pitch link

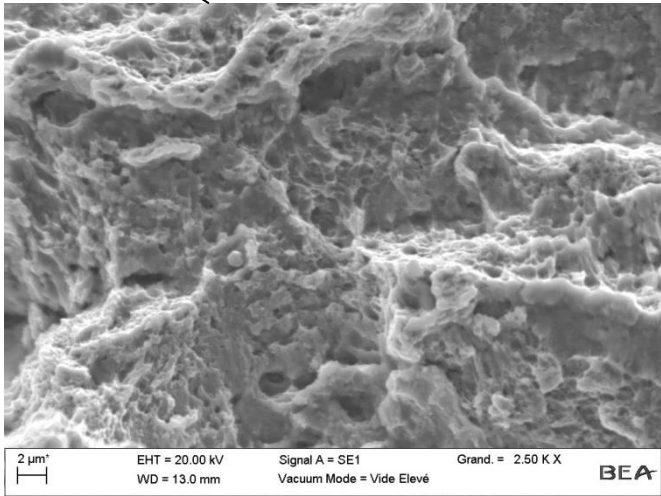
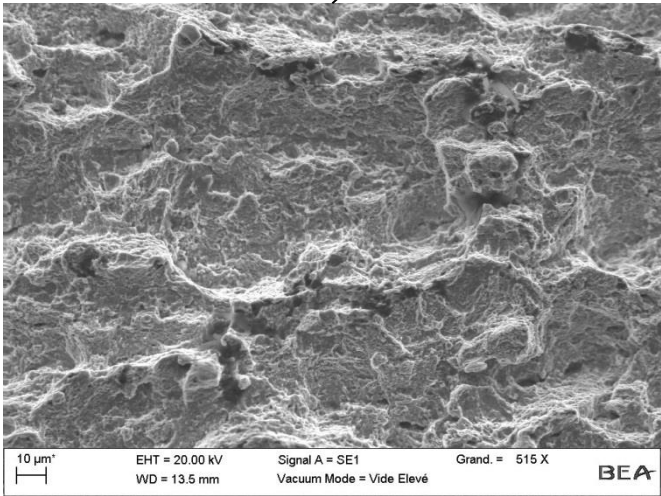
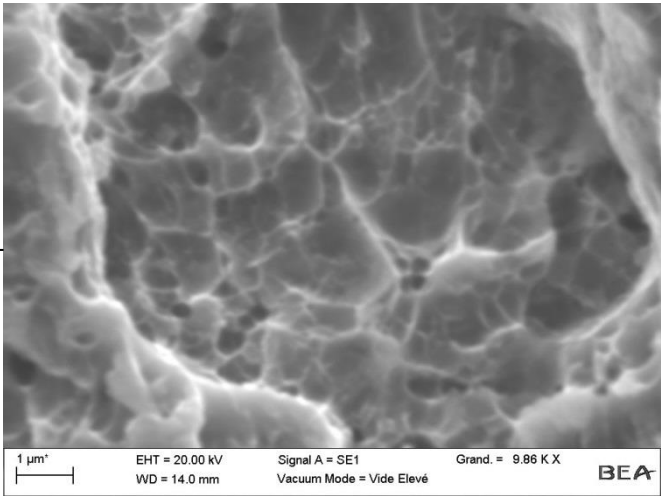
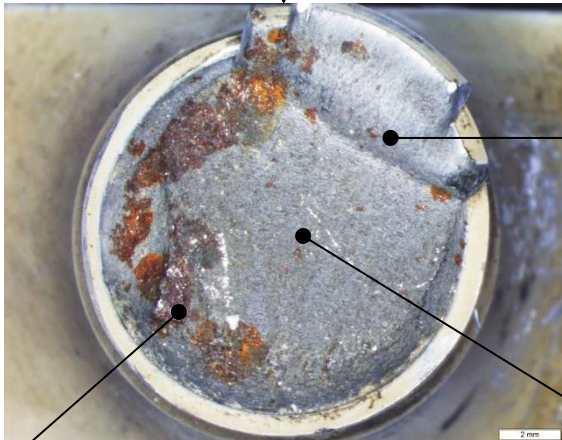


Side view of the fracture surface area after cutting for SEM examination

Scanning Electron Microscope examination – red pitch link



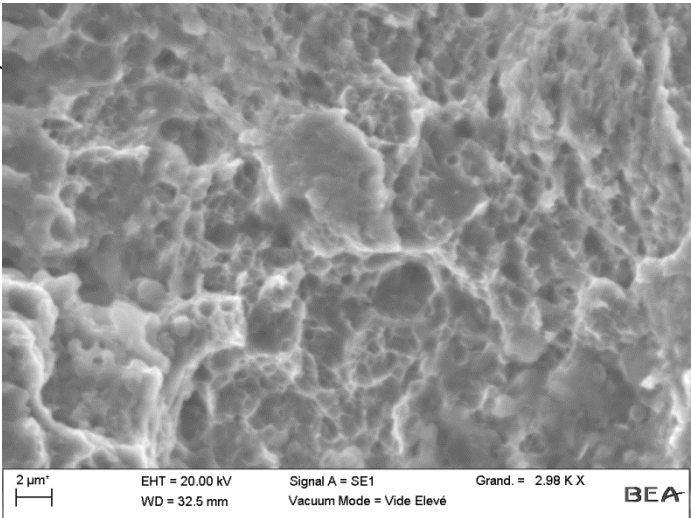
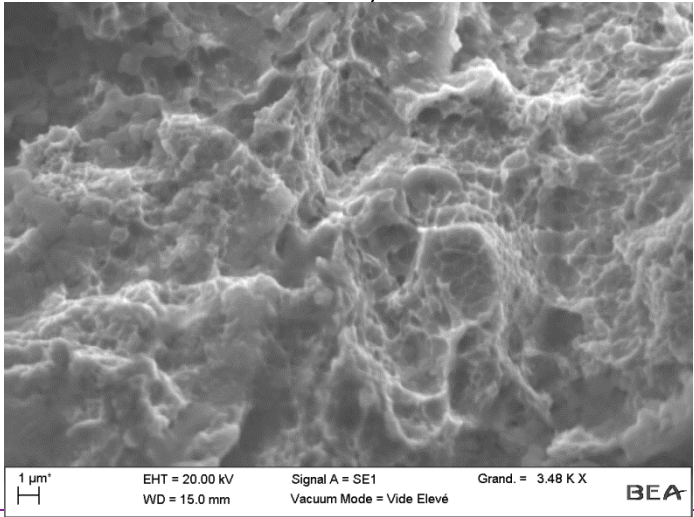
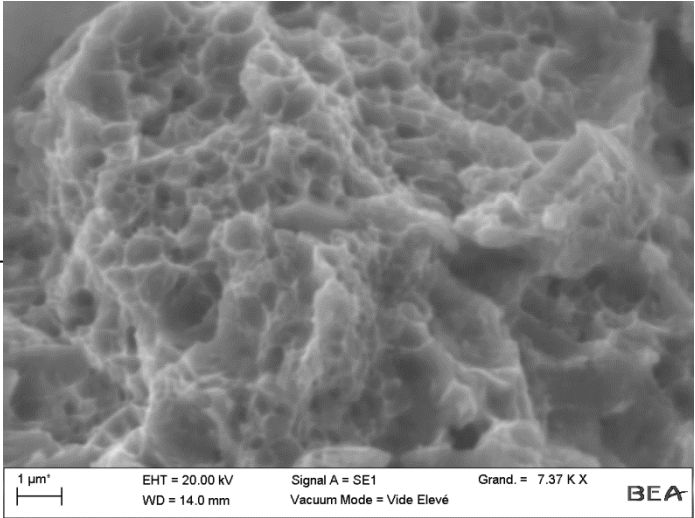
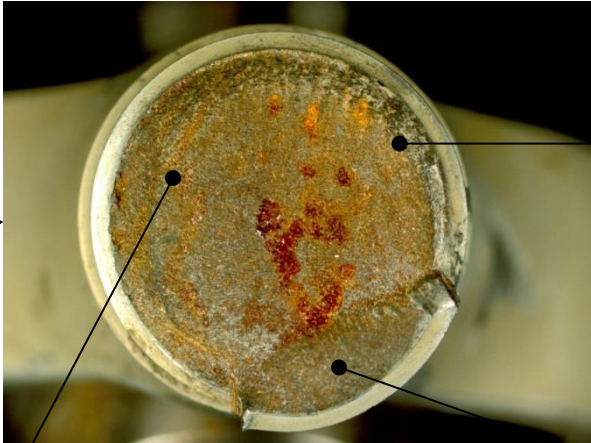
SEM examination of the upper fracture surface of red pitch link showing dimples, typical of sudden failure by overload.



Scanning Electron Microscope examination – yellow pitch link



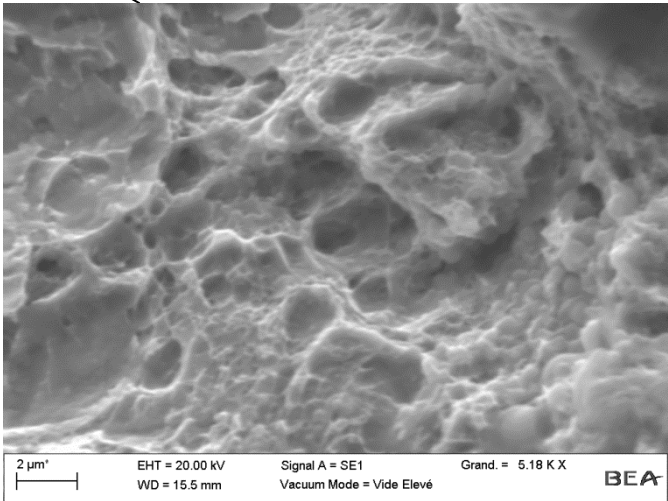
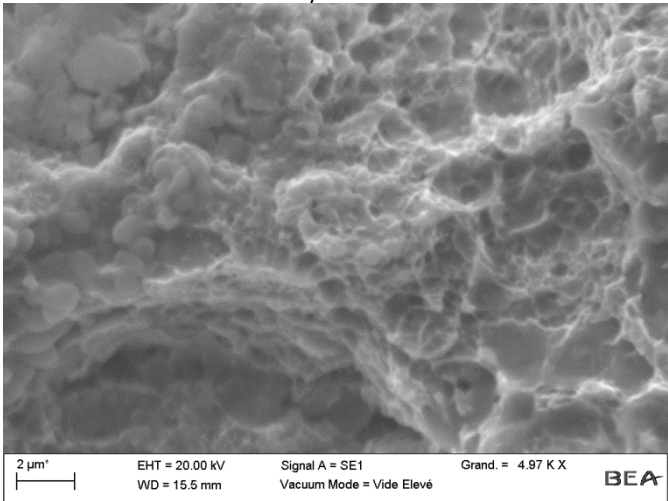
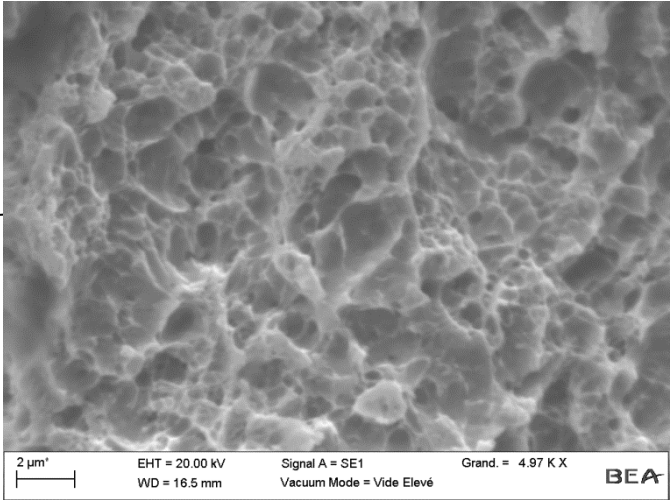
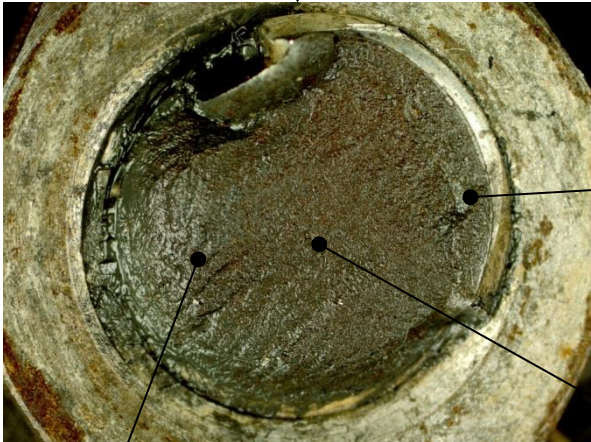
SEM examination of the lower fracture surface of red pitch link showing dimples, typical of sudden failure by overload.



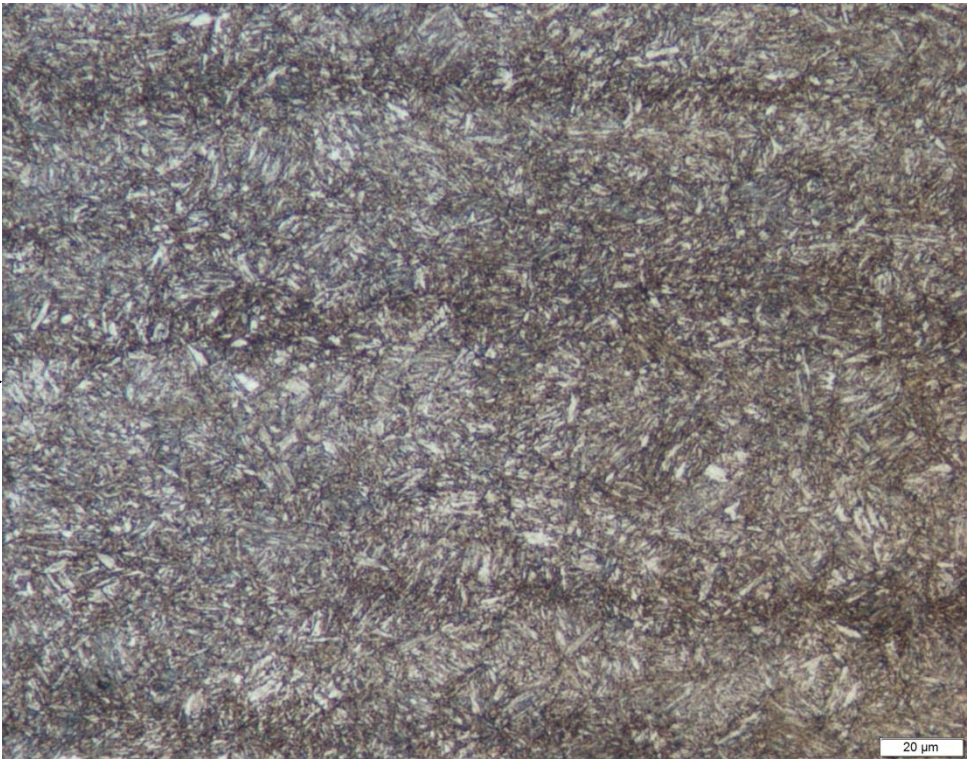
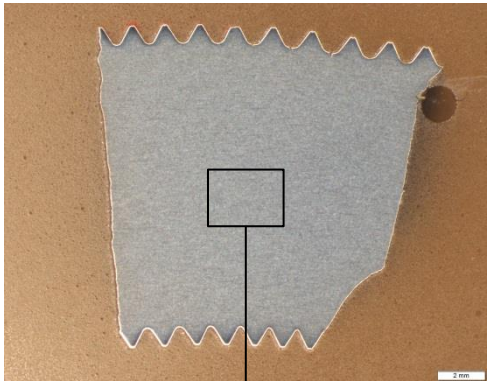
Scanning Electron Microscope examination – blue pitch link



SEM examination of the upper fracture surface of red pitch link showing dimples, typical of a sudden failure by overload.



Metallographic examination of the red pitch link



Micrograph examination showed a martensitic microstructure

Hardness test

Vickers hardness tests were performed on the red pitch link core material, under a load of 30 daN, according to NF-EN-ISO 6507-1 standard.

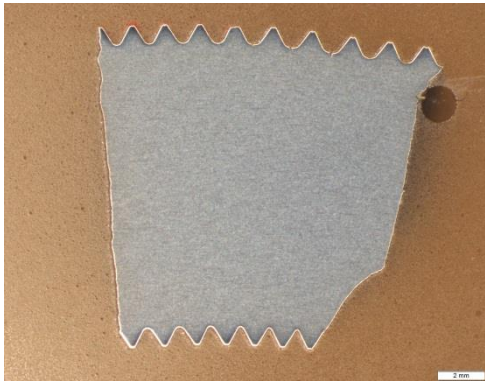
Results are presented in the following table. The obtained hardness values were compliant with material requirements provided by the manufacturer : HRC > 36*.

Location	Measured value
1	370
2	360
3	365
4	365
5	370
6	360
Mean	365 +/- 5 HV30

*according to NF ISO 18265 standard, 360 HV30 is equivalent to 36.6 HRC.

Energy dispersive spectrometry (EDS) analysis

EDS analysis was performed on the core material of the red pitch link. For this analysis, the micrograph sample was used. 3 measurements were done, presented in the following table. The results are consistent with the composition of an AISI 4340 alloy steel.



EDS measurements				
Element	measurement 1	measurement 2	measurement 3	Standard
	%Weight	%Weight	%Weight	%Weight
	Value*	Value*	Value*	Value
Si	0.44 - 0.64	0.32 - 0.52	0.26 - 0.44	0.20 - 0.35
Cr	0.89 - 1.09	0.89 - 1.09	0.73 - 0.91	0.70 - 0.90
Mn	0.58 - 0.84	0.79 - 1.05	0.62 - 0.86	0.65 - 0.85
Fe	95.76 - 96.30	94.78 - 95.50	95.94 - 96.44	base
Ni	1.53 - 1.93	1.92 - 2.32	1.72 - 2.08	1.65 - 2.00
Mo	ND	0.16 - 0.66	ND	0.20 - 0.30
P	ND	ND	ND	0.010 (max)
S	ND	ND	ND	0.010 (max)
Cu	ND	ND	ND	0.10 (max)
Bo	ND	ND	ND	0.001 (max)

ND : Non Detected
* taking measurement uncertainty into account

Corrosion test

A corrosion test was performed in the BEA laboratory, on the core material to be representative of the fracture surface. The sample used was the micrograph sample, coming from red pitch link. A water drop was deposited on the sample and several pictures were taken at several time intervals. Pictures are presented below. The same test performed on the threads (which are coated) did not generate any corrosion.



T = 0s, temp=21.8degC



T = 8,6 s, temp=22degC



T = 51min30s, temp=25.5degC



T = 2h08min32s, temp=26.4degC



T = 16h23min20s, temp=21.7degC



T = 16h23min20s, after cleaning



Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Zone Sud - 200 rue de Paris
Aéroport du Bourget
93352 Le Bourget Cedex - France
T : +33 1 49 92 72 00 - F : +33 1 49 92 72 03
www.bea.aero