Havarikommissionen
Accident Investigation Board Denmark

BULLETIN

Accident

5-8-2016

involving

ELA 07 R-100 C

OY-1027

ECCAIRS Release 5

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FOREWORD

This bulletin reflects the opinion of the Danish Accident Investigation Board regarding the circumstances of the occurrence and its causes and consequences.

In accordance with the provisions of the Danish Air Navigation Act and pursuant to Annex 13 of the International Civil Aviation Convention, the investigation is of an exclusively technical and operational nature, and its objective is not the assignment of blame or liability.

The investigation was carried out without having necessarily used legal evidence procedures and with no other basic aim than preventing future accidents and serious incidents.

Consequently, any use of this bulletin for purposes other than preventing future accidents and serious incidents may lead to erroneous or misleading interpretations.

A reprint with source reference may be published without separate permit.

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BULLETIN

General

File number:	HCLJ520-2016-34
UTC date:	5-8-2016
UTC time:	16:00
Occurrence class:	Accident
Location:	Isortoq Reindeer Station in Greenland
Injury level:	Serious

Aircraft

Aircraft registration:	OY-1027
Aircraft make/model:	ELA Aviation / ELA 07 R-100 C
Current flight rules:	Visual Flight Rules (VFR)
Operation type:	Non-Commercial Operations Pleasure Local
Flight phase:	Take-off
Aircraft category:	Rotorcraft Gyroplane Gyroplane two seats
Last departure point:	Greenland (Isortoq Reindeer Station)
Planned destination:	Greenland (Isortoq Reindeer Station)
Damage to aircraft:	Destroyed
Engine make/model:	Rotax 912

SYNOPSIS

Notification

All times in this report are UTC.

On 6-8-2016 at 10:25 hours, the Aviation Unit of the Danish Accident Investigation Board (AIB) was notified of the accident by a witness.

The Danish Transport and Construction Agency (DTCA) was notified on 6-8-2016.

The Icelandic Transportation Safety Board (RNSA) was notified on 9-8-2016.

The RNSA appointed a non-travelling accredited representative to the AIB safety investigation.

The Spanish Comisión de Investigación de Accidentes e Incidentes de Aviación Civil (CIAIAC) was notified on 7-9-2016.

The CIAIAC did not appoint an accredited representative to the AIB safety investigation.

Summary

During the take-off roll, the gyroplane started veering to the left resulting in the gyroplane running off the side of the runway.

The gyroplane hit a rock and ended up in an almost upside down position.

Fuel started leaking and caught fire, and the gyroplane was destroyed by the fire.

The accident occurred in daylight and under visual meteorological conditions (VMC).

The AIB safety investigation did not result in safety recommendations being made.

FACTUAL INFORMATION

History of the flight

The accident occurred during a local VFR flight.

In the morning, on the day of the accident, the pilot aborted a take-off attempt, because the gyroplane started veering to the left during the take-off roll.

At that point, it was the pilot’s opinion that crosswind conditions led to the veering to the left, and the pilot decided to postpone any further take-off attempts, until the wind had calmed down.

In the afternoon, when the wind had calmed down (light crosswind conditions), the pilot prepared the gyroplane for another take-off attempt (refuelling and positioning of the gyroplane into take-off position).

The engine run up gave no rise to remarks.

The pilot engaged the prerotator and slowly increased the engine power until reaching approximately 240-250 rotor revolutions per minute (RPM).

Then, the pilot added take-off power.

During the take-off roll, the pilot experienced that the gyroplane started veering to the left, and the pilot tried to compensate by adding flight control stick input to the right. The flight control stick input to the right did not appear to have effect, and the gyroplane continued veering to the left.

The pilot realized that it was not possible to abort the take-off attempt in time to avoid rocks in front of the gyroplane, and the pilot unsuccessfully tried to rotate the gyroplane.

The gyroplane hit a rock next to the runway edge and ended up in an almost upside down position.

Fuel started leaking and caught fire.

The pilot succeeded in loosening his seat harness and evacuating the gyroplane, and a witness came to the accident site with a fire extinguisher to extinguish the fire and to help the pilot.

Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal			
Serious	1		
Minor / None			

Damage to aircraft

The gyroplane was destroyed.

Personnel information

License and medical certificate

The pilot - male, 49 years - was the holder of a valid Danish ultralight gyroplane pilot license issued by the DTCA on 2-12-2014.

Furthermore, the pilot was the holder of a valid Icelandic aircraft private pilot license (PPL (A)) issued by the Icelandic Transport Authority on 9-6-2016.

The class rating single engine piston land (SE piston land) was valid until 30-6-2018.

The medical certificate (class 2) was valid until 4-3-2018.

Flying experience in gyroplanes

	Last 24 hours	Last 90 days	Total
All Types (hours)	-	-	Approximately 400
Accident type (hours)	-	-	-
Landings (number)	-	-	-

Airstrip familiarity

The pilot was very familiar with operations on the airstrip.

Rest before flight

The day before the accident flight, the pilot went to bed at 22:00 hours local time and got up in the morning on the day of the accident at 08:00 hours local time.

Aircraft information

<u>General information</u>

The ELA 07 gyroplane was designed as a 2-seater, tandem-configured three-axis gyroplane with dual controls and single engine.

The airframe consisted of a single Tungsten-Inert-Gas (TIG) welded piece made from stainless steel.

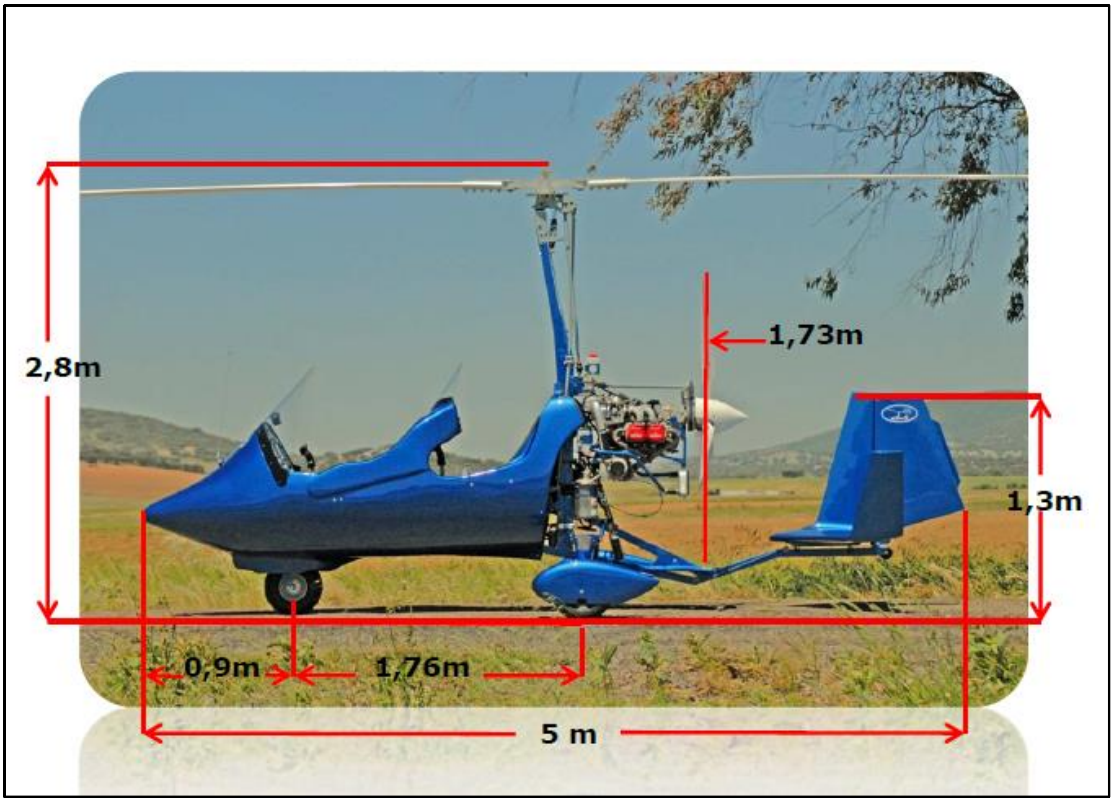
The gyroplane had a tricycle landing gear with front wheel.

The rotor blades were made from aluminum and composite materials.

The power unit consisted of a pusher piston engine and a three-bladed composite propeller.

<u>Overall dimensions</u>

The picture below represents a generic ELA 07 gyroplane.



Front wheel fork, controls rods, and front pedals

OY-1027

Manufacturer:	Ela Aviation
Model:	ELA 07 R-100 C
Serial number:	0113180712
Engine:	Rotax 912
Permit to fly:	Issued on 25-7-2016 by the Danish Gyrocopter Union (DGU) and valid until 7-6-2018 or 485 gyroplane flying hours
Gyroplane flying hours:	383.1 hours
Maintenance:	The gyroplane was maintained in accordance with instructions by the DGU
Repair:	As a consequence of a previous accident in year 2014, the gyroplane was rebuilt
Inspection:	On 6-6-2016, the gyroplane was inspected and approved by a DGU inspector

Pilot Operator's Handbook (POH) (extracts)

3.7 WIND

- *Cross wind: Maximum cross wind for take-off and landing is 16 Kn, always keeping the nose wheel off the ground until fully stopped after landing.*

- *Tail wind: Maximum tail wind for take-off and landing is 5 Kn.*

4.5 ROTOR PREROTATION

1. *Alignment: Runway alignment.*

2. *Engine: Move the throttle until the engine speed reaches 2200 rpm.*

3. *Flight position: Hold the stick fully forward and centred with your right hand. With your left hand, select the "Flight" position for the pneumatic valve. Wait five seconds for the pneumatic system to fully charge.*

4. *Pre-rotation: Push and hold the pre-rotator button on the control stick with your thumb. This causes the prerotator to engage. You will hear the prerotator belt making some squeak, wait until the prerotator belt doesn´t make noise, then increase the engine power slowly and gradually until reaching 220 rotor rpm.*

Warning

Before engage the prerotator, check area is clear and consider the risk that passenger's hair or loose garment can be caught by the prerotator drive shaft.

For shorter take-off it is advisable to increase the rotor rpm up to 300 but the stress of the prerotation system will be higher so don´t do it if it's not necessary.

Caution

Start the take-off with the rotor between 150 - 200 rpm requires a high skill. It is forbidden to proceed with take-off operations if the rotor is under 150 rpm.

4.6 TAKEOFF

Once the prerotation procedure is finished gently move the control stick fully back to its stop, release wheel brakes and increase the engine power progressively.

Warning

Make sure the control stick is fully back before start the take-off run. A take-off run with flat rotor may have fatal consequences.

Use the rudder pedals to keep the alignment of the runway (right pedal).

Once the nose wheel lifts, move the control stick forward to keep it at approx. 10 cm off the ground while the gyroplane accelerates.

When the gyroplane takeoffs do a level flight until reach 100 km/h (best rate of climb) and then raise the nose to keep this speed.

Use the pitch trim to adjust the speed of the gyroplane:

- *Trim back = Nose up = reduce speed.*
- *Trim forward = Nose down = increase speed.*

Note

Remember: adjust the speed with the control stick, climb and descend with engine power.

Once reached the safe altitude, reduce the engine power to maintain the flight level at the desired speed.

Meteorological information

Pilot information

Wind conditions:	Variable 6 knots
Visibility:	More than 10 kilometres
Clouds:	Sky clear
Temperature:	10° Celsius

Aftercast

Position:	60°59'02''N 47°31'11''W (Isortoq Reindeer Station)
Wind conditions:	The surface wind at the accident site was most likely westerly and 10 knots or weaker
Visibility:	More than 10 kilometres
Clouds:	Sky clear

Aviation routine weather report (METAR) for nearby aerodromes

Narsarsuaq	bgbw 051550z 24006kt 220v290 9999 few200 17/m03 q1014 rmk 1cs=
Narsaq	bgns 051520z 31004kt 240v040 9999 sct100 14/m01 q1014=
Qaqortoq	bgjh 051650z 27010kt 240v320 9999 sct055 13/05 q1014=

SYNOP observations

For nearby SYNOP observations at 16:00 hours - see appendix 1.

Airstrip information

The reindeer station at Isortoq had its own compacted gravel airstrip.

The runway represented an almost triangle runway. The take-off end towards the west (magnetic) was 70 meters wide narrowing down to 20 meters wide at the runway end.

The runway length was 160 meters.

See appendix 2.

Wreckage and impact information

Intended take-off roll
Actual take-off roll

During the take-off roll, the gyroplane started veering to the left and hit a rock next to the runway edge.

See the picture below.

The gyroplane ended up in an almost upside down position.

Fuel started leaking and caught fire, and the gyroplane was destroyed by the fire.

See the picture below.

Post impact fire

A fire erupted during the final impact sequence and was sustained by the fuel on board the gyroplane.

Survival aspects

Use of harness

The pilot used the on board lap and diagonal seat harness.

Survivability

Upon impact, the pilot succeeded in loosening his seat harness and evacuating the gyroplane.

AIB technical investigation

The AIB instituted a metallurgic examination of the front wheel steering assembly.

See appendix 3.

ANALYSIS

General

The observed weather conditions in the area of Isortoq Reindeer Station were generally equivalent to the nearby reported weather conditions.

The actual weather conditions did not give rise to any operational safety considerations.

The license, the qualifications, and the medical status held by the pilot had, in the AIB's opinion, no influence on the sequence of events.

Furthermore, the pilot was familiar with the airstrip, and the pilot did apparently not suffer from fatigue.

Take-off roll

The AIB considers the handling of the gyroplane during the take-off roll to be in compliance with the recommended gyroplane take-off operating procedures.

The AIB has not been able to reveal the direct cause of the unintended veering to the left during the take-off roll.

Because of a combination of the front wheel marks on the ground towards the accident site and the nature of the multiple overload failures of the front wheel assembly, the AIB has reason to believe that the front wheel did neither collapse nor separate from the gyroplane until impact with the rock next to the runway edge.

Survivability

The AIB finds the gyroplane impact with the rock next to the runway edge to be survivable.

However, the erupted post impact fire increased the risk of fatal injuries, and in the opinion of the AIB an immediate and fortunate evacuation from the gyroplane was the difference between serious and fatal injuries.

CONCLUSIONS

During the take-off roll, the gyroplane started veering to the left resulting in the gyroplane running off the side of the runway and hitting a rock.

A combination of the front wheel marks on the ground towards the accident site and the nature of the multiple overload failures of the front wheel assembly indicates that the front wheel did neither collapse nor separate from the gyroplane until impact with the rock next to the runway edge.

APPENDIX 1

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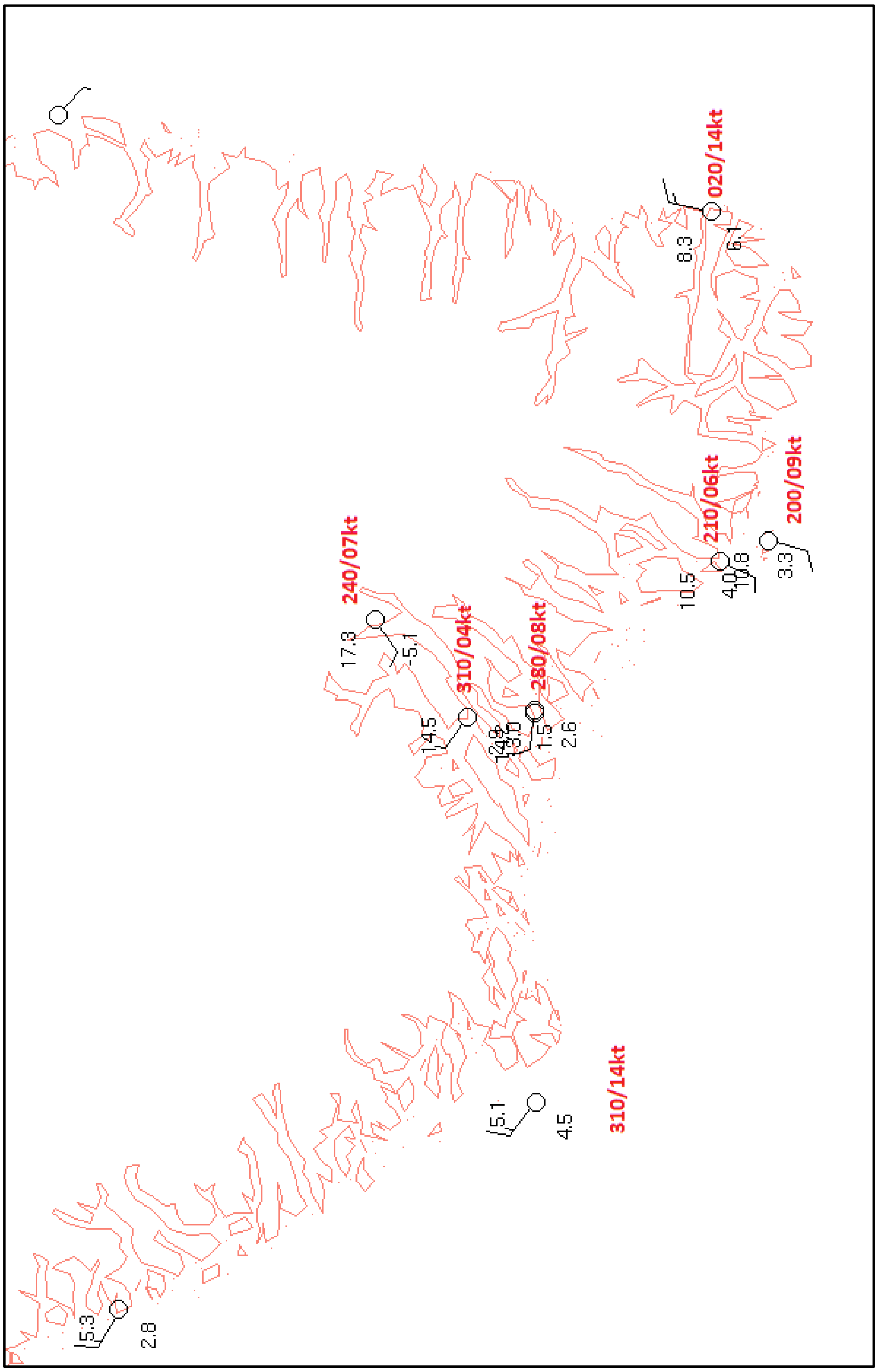

APPENDIX 2

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APPENDIX 3

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FORCE TECHNOLOGY

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OVERVIEW OF APPENDICES

Appendix 1: Photo documentation

Background information

At your request, FORCE Technology has examined the supplied components, as seen in Figure 1, from an Ela Aviacion gyrocopter, with registration number OY-1027, to determine the causes of failure in selected positions.

Purpose of examination

The scope of our examination has been outlined according to your requests for the following components and to establish their causes of failure;

1. Forward left hand steering rod
2. Aft left hand steering rod
3. Aft right hand steering rod
4. Forward right hand steering rod
5. Nose wheel steering fork end

For ease of reference, Figure 2 illustrates the positions of the abovementioned components to be examined.

Examination and results

Visual inspection

The main steering frame showed significant signs of deformation with the steering rod mounting plate and nose wheel steering column bent extensively c.f. figure 3.

The forward left steering rod, as well as both left and right aft steering rods had visible fracture surfaces with signs of corrosion in their threaded regions, cf. figures 4 - 6. Following cleaning and removal of the corrosional products on all three fracture-surfaces, the topography displayed an intergranular structure with selected areas of cracking, suggesting that the failure mode could be ductile fracture cf. Figures 7 – 9.

The forward right hand steering rod assembly had no visible fracture surfaces, but was forced off its fastening bearing which remained on the main steering frame as seen in Figure 3. The threaded rod ends were also examined and showed no signs of comparable damage to their counterparts cf. figures 10 and 11.

The nose wheel steering fork had no signs of corrosion, but had an elliptical semi-circumferential fracture surface, which may be seen in Figure 12 and at higher magnification in figures 13 and 14.

Scanning electron microscopy

In order to ascertain the individual failure modes of each component, the fracture surfaces were examined in more detail in Scanning Electron Microscopy (SEM).

The forward left hand steering rod fracture surface could be categorised as being the result of ductile fracture as seen by the general shear dimple morphology in a torsional orientation cf. Figure 15. The centre of the bolt did however display partial signs of brittle fracture within the shear dimples, suggesting that the failure of the threaded rod section occurred almost instantaneously cf. Figure 16.

The aft left hand steering rod fracture surface also displayed signs of torsional deformation through ductile fracture as confirmed by the presence of shear dimples cf. Figures 17 - 18.

The aft right hand steering rod fracture surface, similarly to the before mentioned, exhibited ductile fracture confirmed by shear dimples cf. Figure 19. However, in contrast to the left forward and aft fracture surfaces, the orientation of the shear dimples is more tensile in orientation as opposed to a torsional deformation cf. Figure 20.

The nose wheel steering fork fracture surface was categorised as being the result of ductile fracture seen by a general shear dimple morphology in a tensile orientation at both the left and right sides of circumferential fracture surface c.f. Figure 21 - 23.

Conclusion

Based on our examination, we can conclude the following;

Failure of the left (aft and forward) hand side rods has been the result of ductile fracture influenced by torsional forces as seen by the orientation of the shear dimples.

Failure of the right hand aft side rod has also been the result of ductile fracture; however, this was more tensile in orientation as seen in shear dimples.

The forward right hand steering rod assembly had no visible fracture surfaces and dislocated from the steering frame bearing, because of a significant outwards acting force.

Failure of the nose wheel steering fork was the result of ductile fracture in a tensile manner as seen by shear dimple orientation.

The causes of failure for all the above mentioned components are the result of overload failure under the influence of either torsional or tensile forces.

APPENDIX 1 Photo documentation
(13 appendix pages including this page)

Figure 1 Components as received by FORCE Technology for examination.

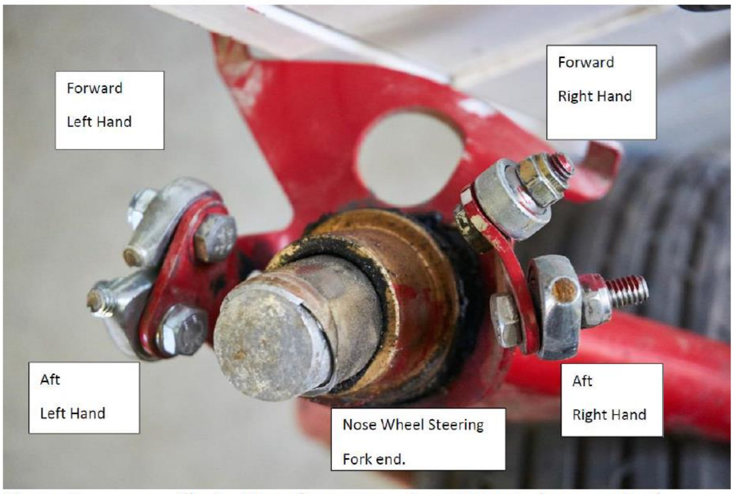

Figure 2 Illustration of component positions to be examined.

Figure 3 Main steering frame with significant signs of deformation.

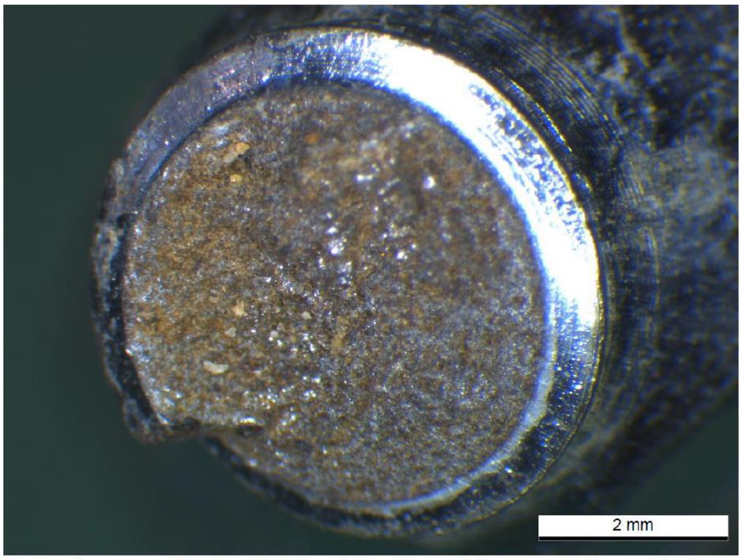

Figure 4 Forward left hand steering rod fracture surface with signs of surface corrosion.

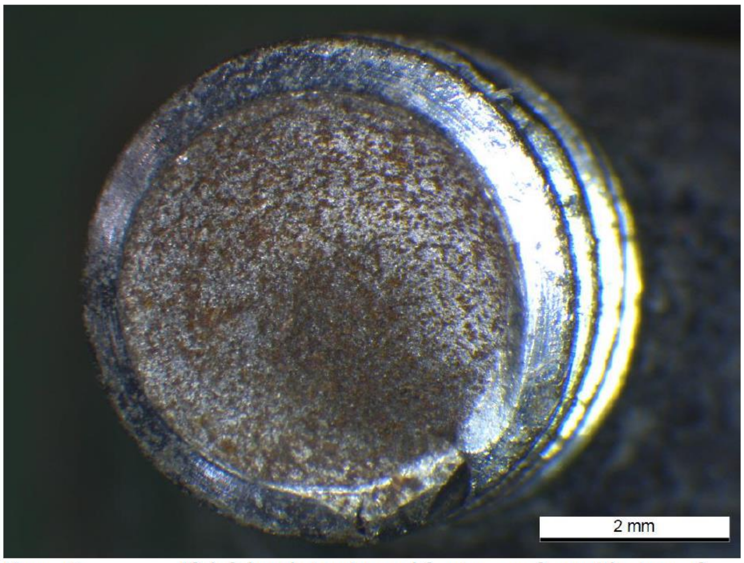

Figure 5 Aft left hand steering rod fracture surface with signs of surface corrosion.

Figure 6 Aft right hand steering rod fracture surface with signs of surface corrosion.

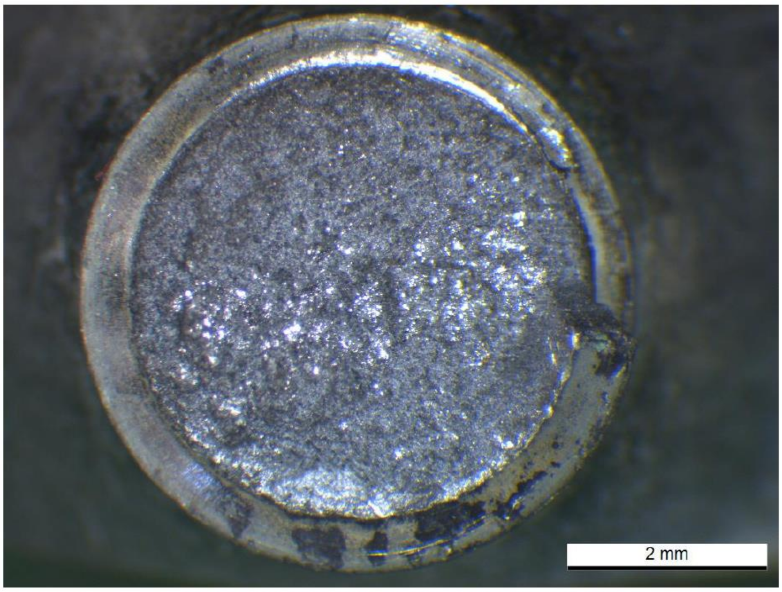

Figure 7 Forward left hand steering rod fracture surface in cleaned condition.

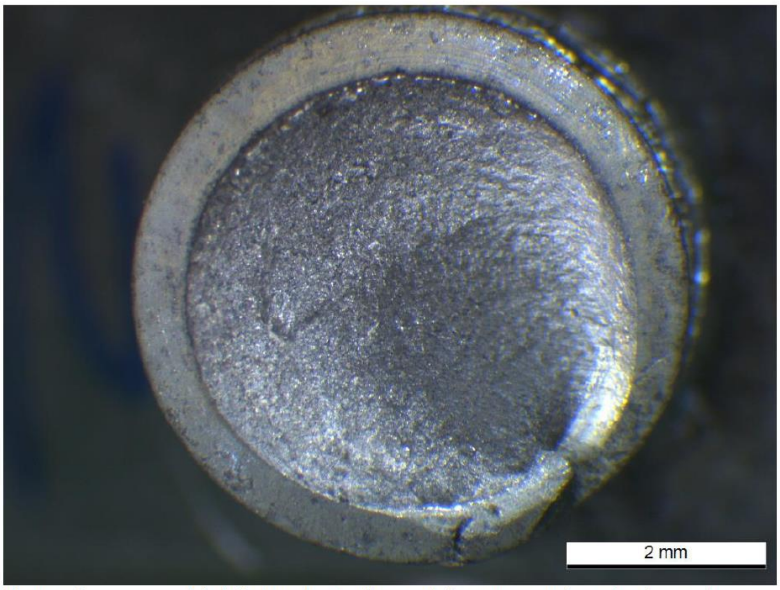

Figure 8 Aft left hand steering rod fracture surface in cleaned condition.

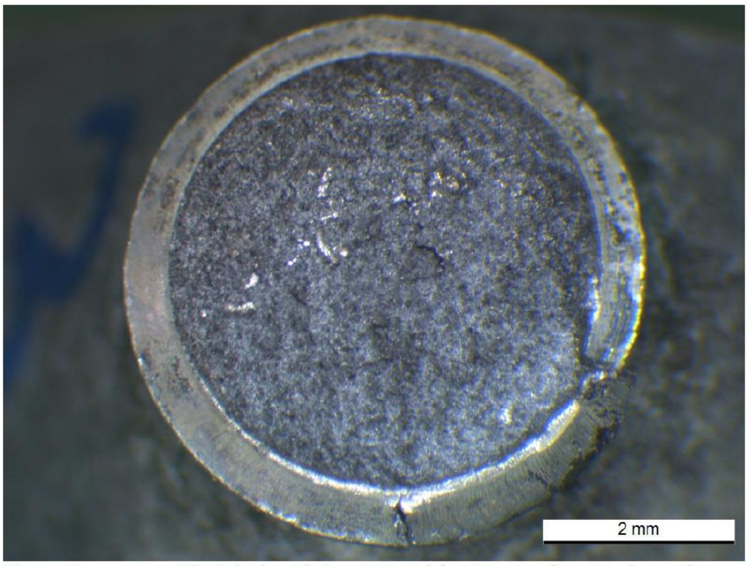

Figure 9 Aft right hand steering rod fracture surface in cleaned condition.

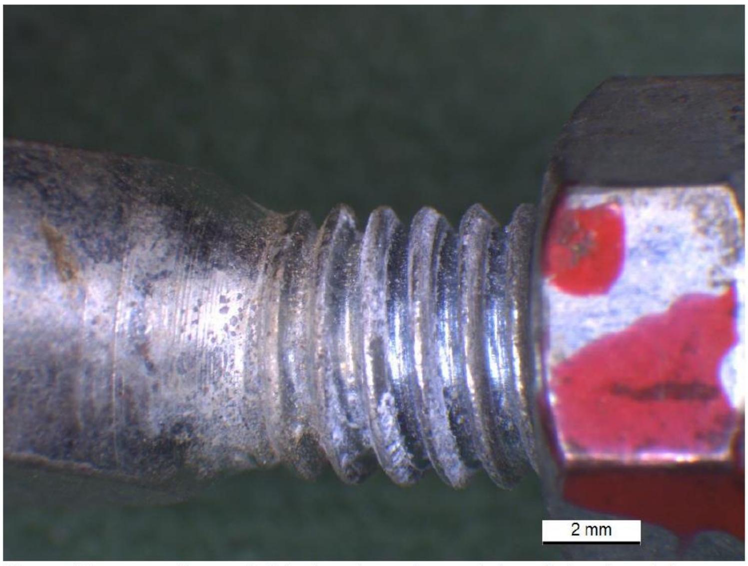

Figure 10 Forward right hand steering rod threaded rod end, free of fracture marks and corrosion.

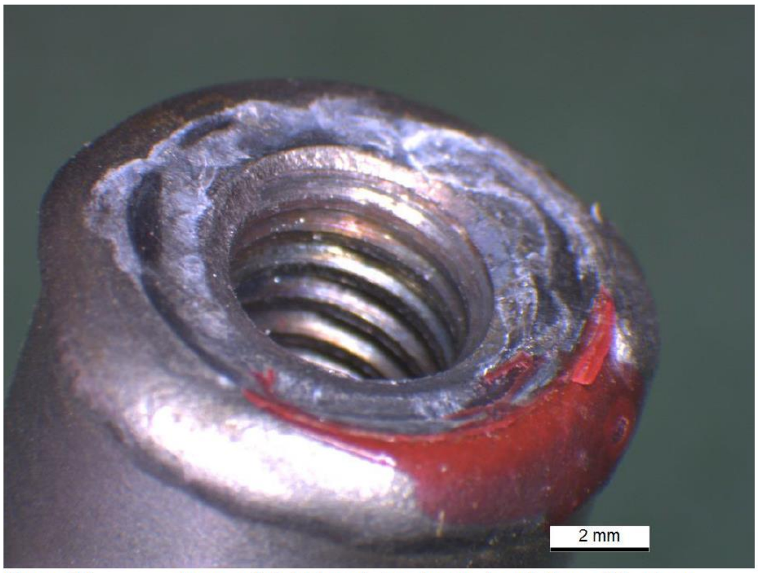

Figure 11 Forward right hand steering rod end, free of fracture marks and corrosion, surface markings are an attribute of assembly.

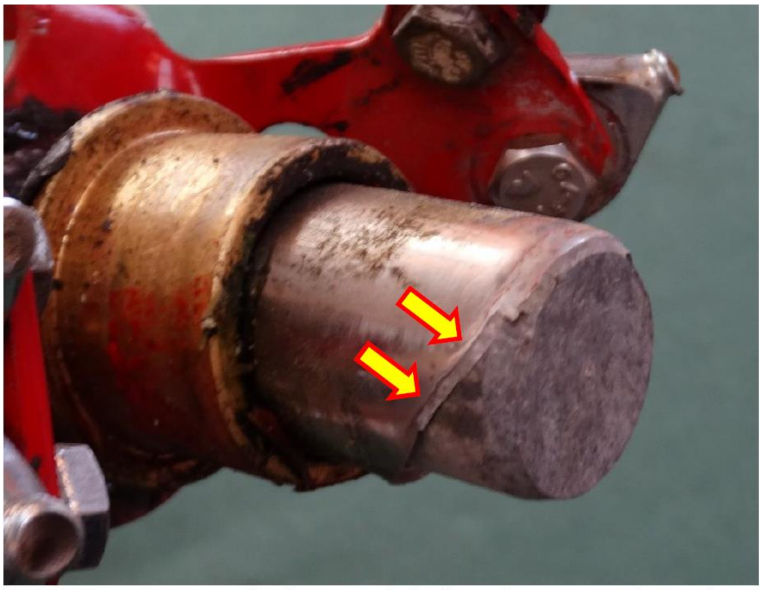

Figure 12 Nose wheel steering fork elliptical semi-circumferential fracture surface, yellow arrows denote left side fracture surface.

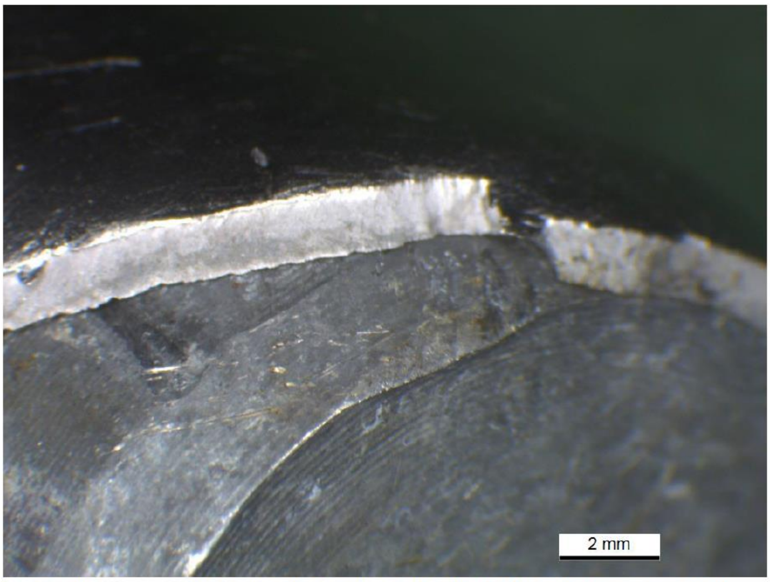

Figure 13 Nose wheel steering fork elliptical semi-circumferential left side fracture surface at higher magnification.

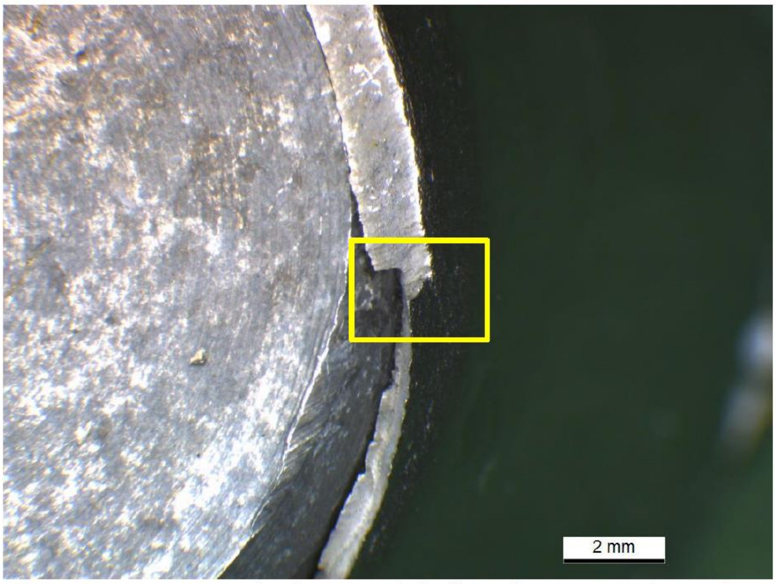

Figure 14 Nose wheel steering fork elliptical semi-circumferential right side fracture surface at higher magnification. Yellow box denotes the region seen in Figure 21.

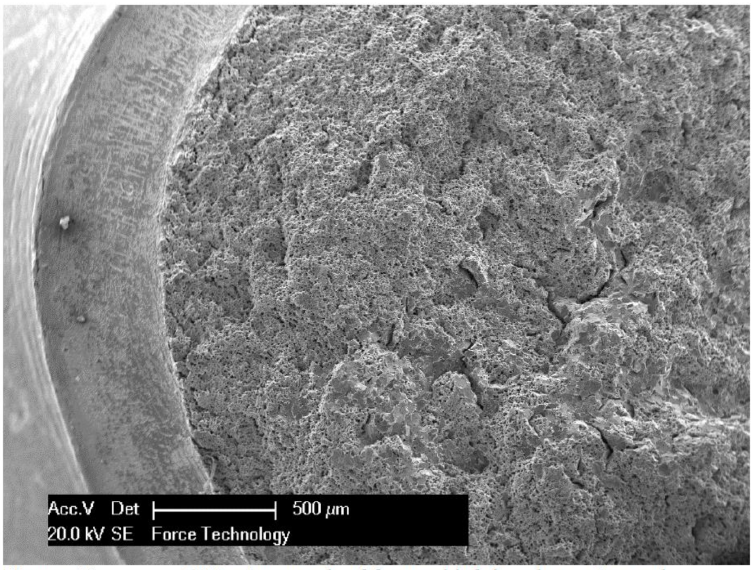

Figure 15 SEM micrograph of forward left hand steering rod fracture surface.

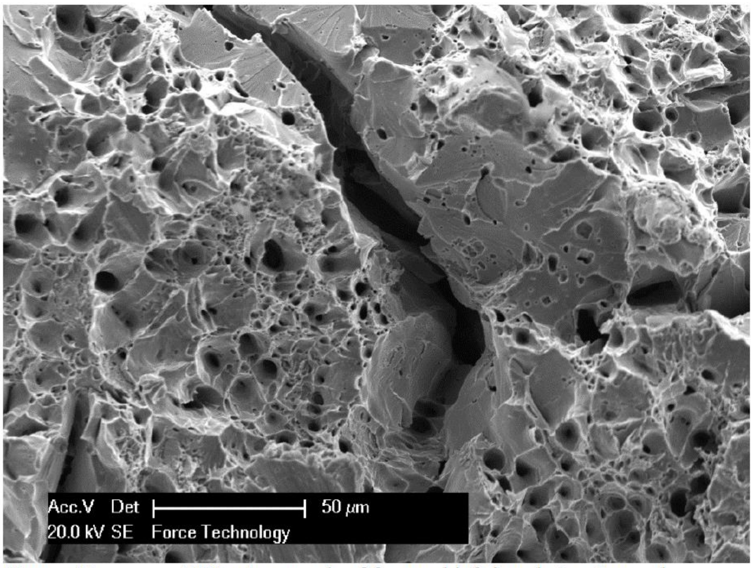

Figure 16 SEM micrograph of forward left hand steering rod fracture surface showing partial signs of brittle fracture surrounded by shear dimples.

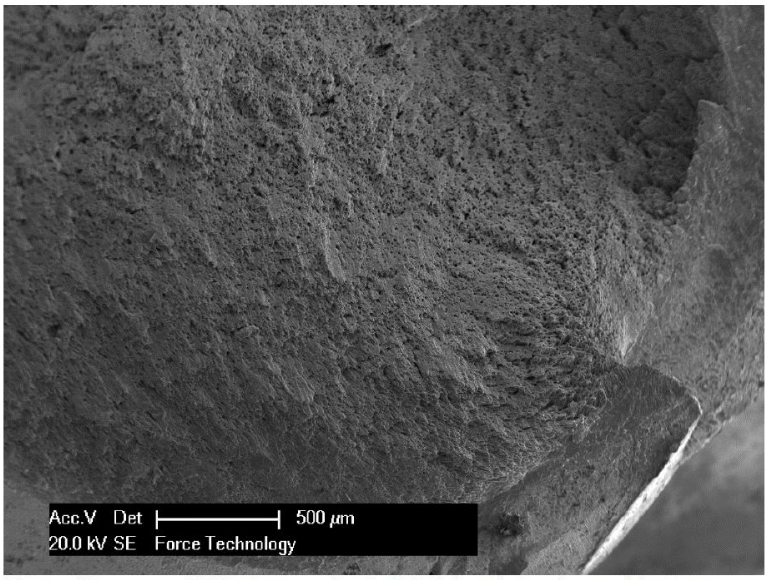

Figure 17 SEM micrograph of aft left hand steering rod fracture surface.

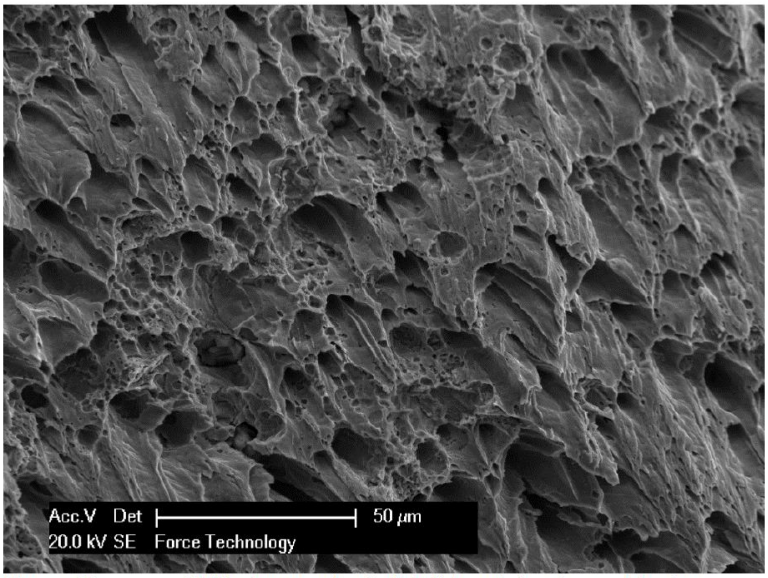

Figure 18 SEM micrograph of aft left hand steering rod fracture surface displaying ductile fracture confirmed by shear dimples.

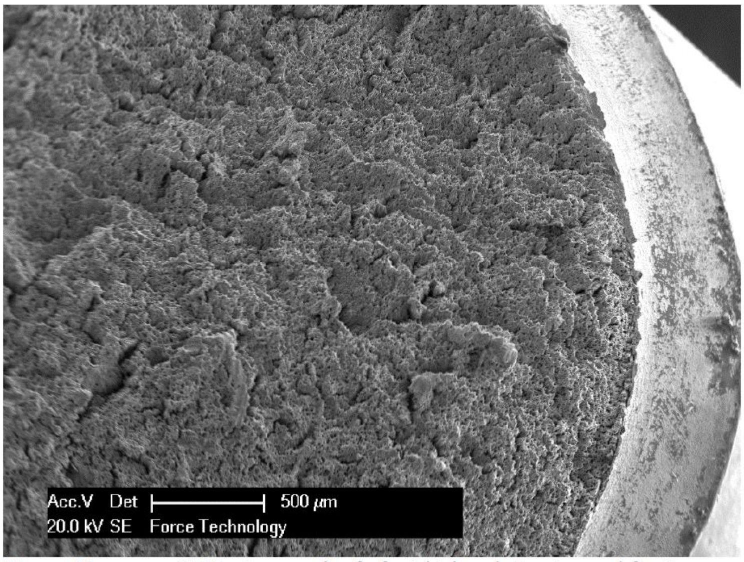

Figure 19 SEM micrograph of aft right hand steering rod fracture surface.

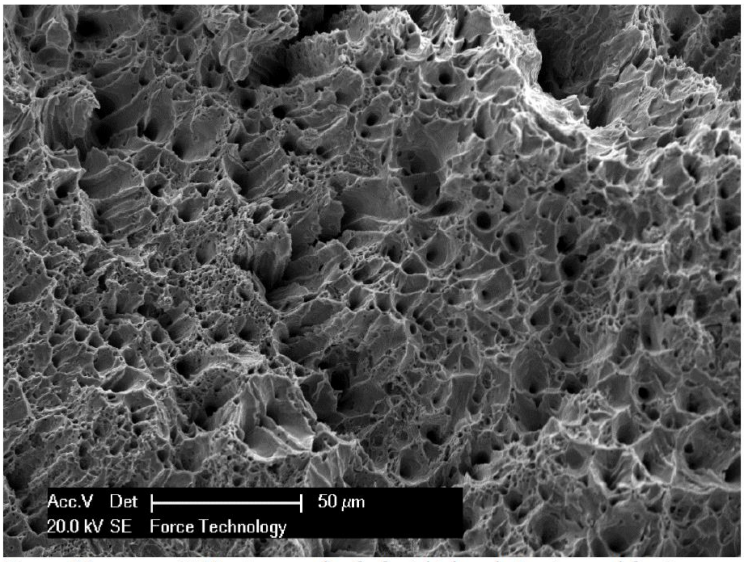

Figure 20 SEM micrograph of aft right hand steering rod fracture surface displaying ductile fracture confirmed by shear dimples.

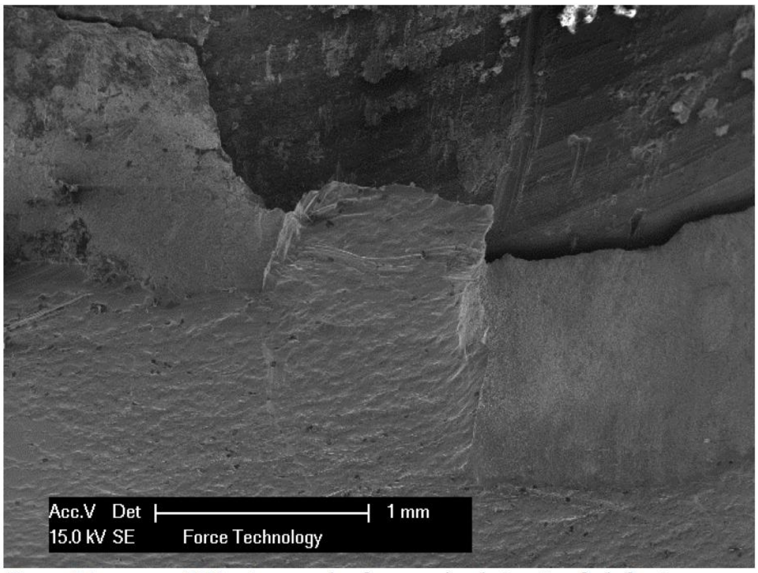

Figure 21 SEM micrograph of nose wheel steering fork fracture surface, location reference can be seen in Figure 14.

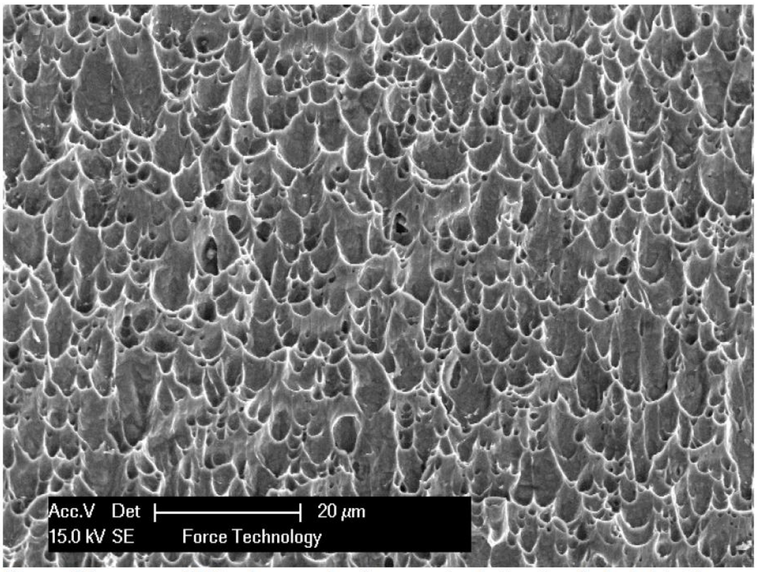

Figure 22 SEM micrograph of nose wheel steering fork right side fracture surface displaying ductile fracture confirmed by shear dimples.

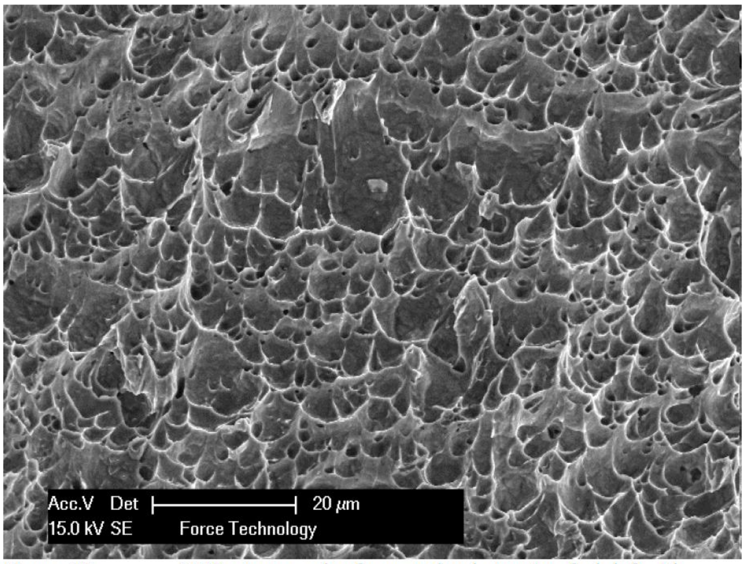

Figure 23 SEM micrograph of nose wheel steering fork left side fracture surface displaying ductile fracture confirmed by shear dimples.