

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



August 28, 2020

MATERIALS LABORATORY FACTUAL REPORT

Report No. 20-024

A. ACCIDENT INFORMATION

Place : Pocahontas, Iowa
Date : September 6, 2019
Vehicle : Cessna 195A, N9895A
NTSB No. : CEN19LA322
Investigator : Mitchell Gallo, AS-CEN

B. COMPONENTS EXAMINED

Pieces of a main landing gear spring strut (left side)

C. DETAILS OF THE EXAMINATION

On September 6, 2019, at 1230 central daylight time, a Cessna 195A, N9895A, impacted terrain after it veered off runway 30 at Pocahontas Municipal Airport (POH), Pocahontas, Iowa. The airplane sustained substantial damage. The pilot and a passenger were uninjured.

Figure 1 shows photographs of the fractured left main landing gear spring strut as received. The spring strut fractured at approximately 7 $\frac{1}{8}$ inches from the inboard edge at the forward side and approximately 6 $\frac{1}{8}$ inches from the inboard edge at the aft side. A light gray paint coating appeared over the entire part surface and a darker gray paint coating was only present on the outboard piece with a clearly delineated inboard boundary. Both gray coatings were chipped and absent from numerous locations over the part surface thereby exposing areas of the underlying light gray coating as well as areas of brownish-red oxidized metal. A visibly distinct band of brighter light-gray coating and exposed oxidized metal was apparent on the upper and lower surfaces of the spring strut on both sides of the fracture as indicated between the white dashed lines. The upper surface of the spring strut was visibly smoother than the lower surface, which exhibited a dimpled texture.

X-ray fluorescence (XRF) spectroscopy was performed using an Olympus Vanta-VCR handheld XRF alloy analyzer and identified a composition primarily of iron with lesser concentrations of elements including silicon, chromium, manganese, vanadium, molybdenum, and copper, consistent with a low alloy steel material.

Figure 2 shows a photograph of the inboard fracture surface. The mating outboard fracture surface exhibited significant post-fracture mechanical damage and oxidation which obscured some of the finer fracture details. The fracture origin was located on the upper

surface at the forward edge of the spring strut. Chevron marks¹ radiated outward from this location along the upper surface and toward the lower surface consistent with an aft and downward crack propagation direction as indicated with yellow arrows. Shear lip² features were present around the perimeter of the fracture surface. Closer examination of the origin area revealed a small discolored thumbnail shaped crack and ratchet mark³ features which were consistent with fatigue cracking⁴ from multiple origins. The upper surface of the spring strut adjacent to the thumbnail shaped crack at the fracture origin was absent of gray coating and had exposed oxidized metal over an area approximately 1 inch inboard of the fracture surface and approximately 0.75 inch aft of the forward edge. This area was pitted and rougher than the surrounding upper surface where gray coating was intact. Reddish-orange staining was also observed near the fracture origin on the surrounding gray coating.

A closer digital microscope image of the fracture origin area and adjacent upper surface of the spring strut is shown in figure 3. The thumbnail shaped pre-existing crack region highlighted with the yellow dashed line was relatively flat and smooth compared to the rest of the fracture surface. Crack arrest lines were evident progressing from at least three origins separated by two visible ratchet marks identified by white arrows. Smaller, semi-elliptical sections bounded by crack arrest lines within the thumbnail crack were brownish-red in color, and progressively lighter in color away from the origins. The pre-existing crack measured approximately 0.131 inch along the upper surface of the spring strut and extended approximately 0.058 inch into the part. The fracture surface morphology outside of the thumbnail shaped pre-existing crack was dull and rough in appearance, consistent with overstress separation.

Michael Meadows
Materials Engineer

¹ Chevron marks are a fractographic pattern of lines on a fracture surface that radiate from the fracture origin and are visible to the unaided eye or at low magnification that look like nested letters "V". The points of the chevrons can be traced back to the fracture origin.

² A shear lip is a 45-degree lip of material around the perimeter of a ductile overstress fracture area.

³ Ratchet marks are slight vertical steps in the fracture that link slightly offset planes of fatigue cracking at a fatigue origin area. Ratchet marks generally are aligned in the direction of cracking and taper off as distance from the origin is increased and a unified crack front is produced.

⁴ Fatigue cracking is a ductile cracking mechanism that initiates and grows, under repeated application of cycles of stress, at a level below the yield stress.

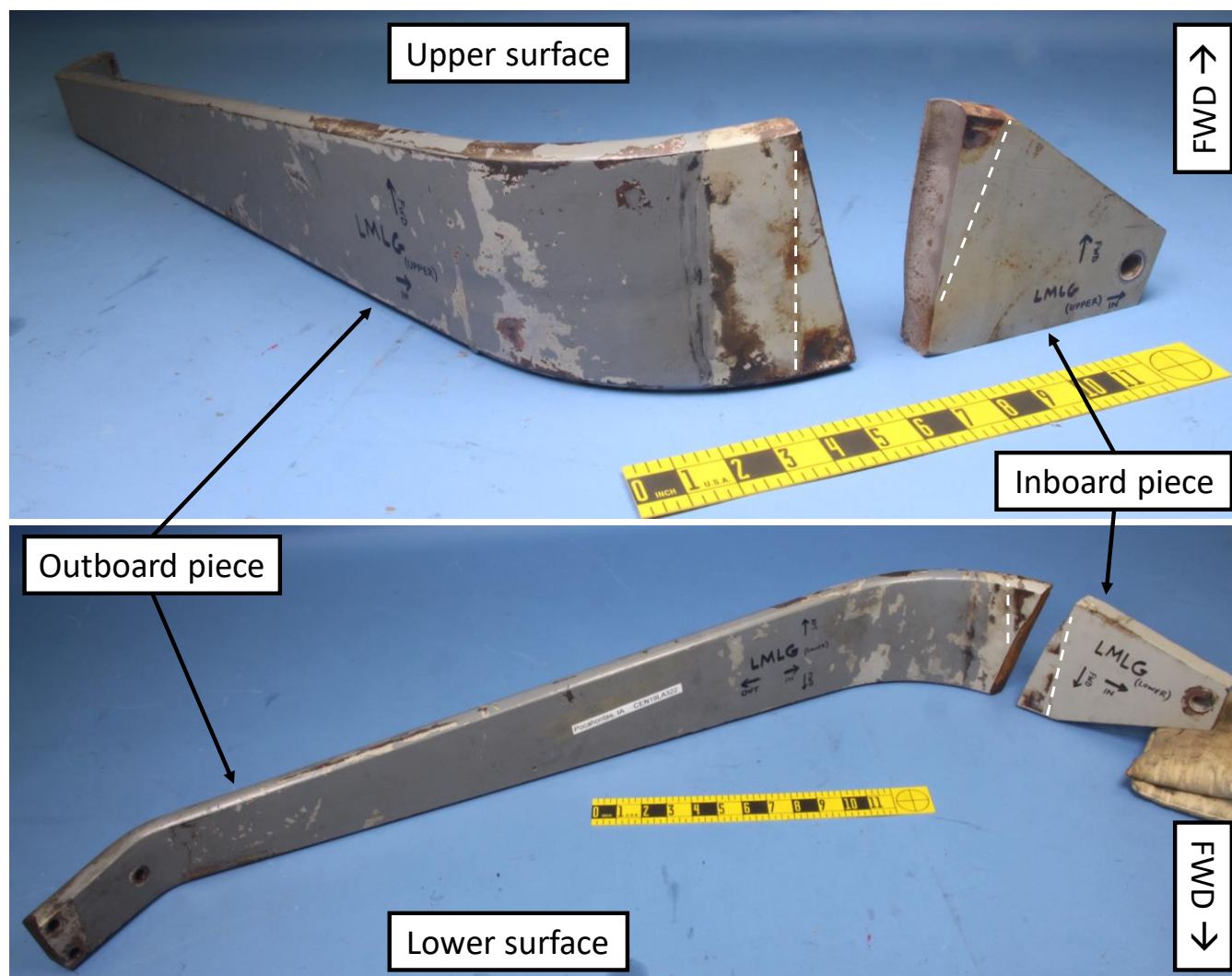


Figure 1: Photographs of the fractured left main landing gear spring strut as received. The top photograph shows a view of the upper surface of the component and the bottom photograph shows a view of the lower surface of the component. A light gray coating was apparent over most of the part surface which was covered by a darker gray coating outboard of the fracture. A distinct band of coating wear was evident between the dashed white lines on each side of the fracture surface. More random areas of chipped and worn coating was observed over the rest of the part surface.



Figure 2: A photograph of the inboard fracture surface is shown above. Chevron patterns pinpointed the fracture origin at the corner of the upper surface and forward edge, indicated by the unlabeled black arrow. From the origin, the crack propagated aft and downward as indicated by the yellow arrows. A closer view of the origin is shown below from the area within the dashed black box, scale markings are 1/16 inch. A relatively flat and smooth thumbnail shaped crack, outlined by the yellow dashed line, and ratchet mark features, indicated by white arrows, were present at the fracture origin, consistent with fatigue initiation from multiple origins. Paint was chipped and absent from the surface adjacent to the origin and brownish-red oxidized metal was visible. Intact paint surrounding this area exhibited a light orange staining pattern.

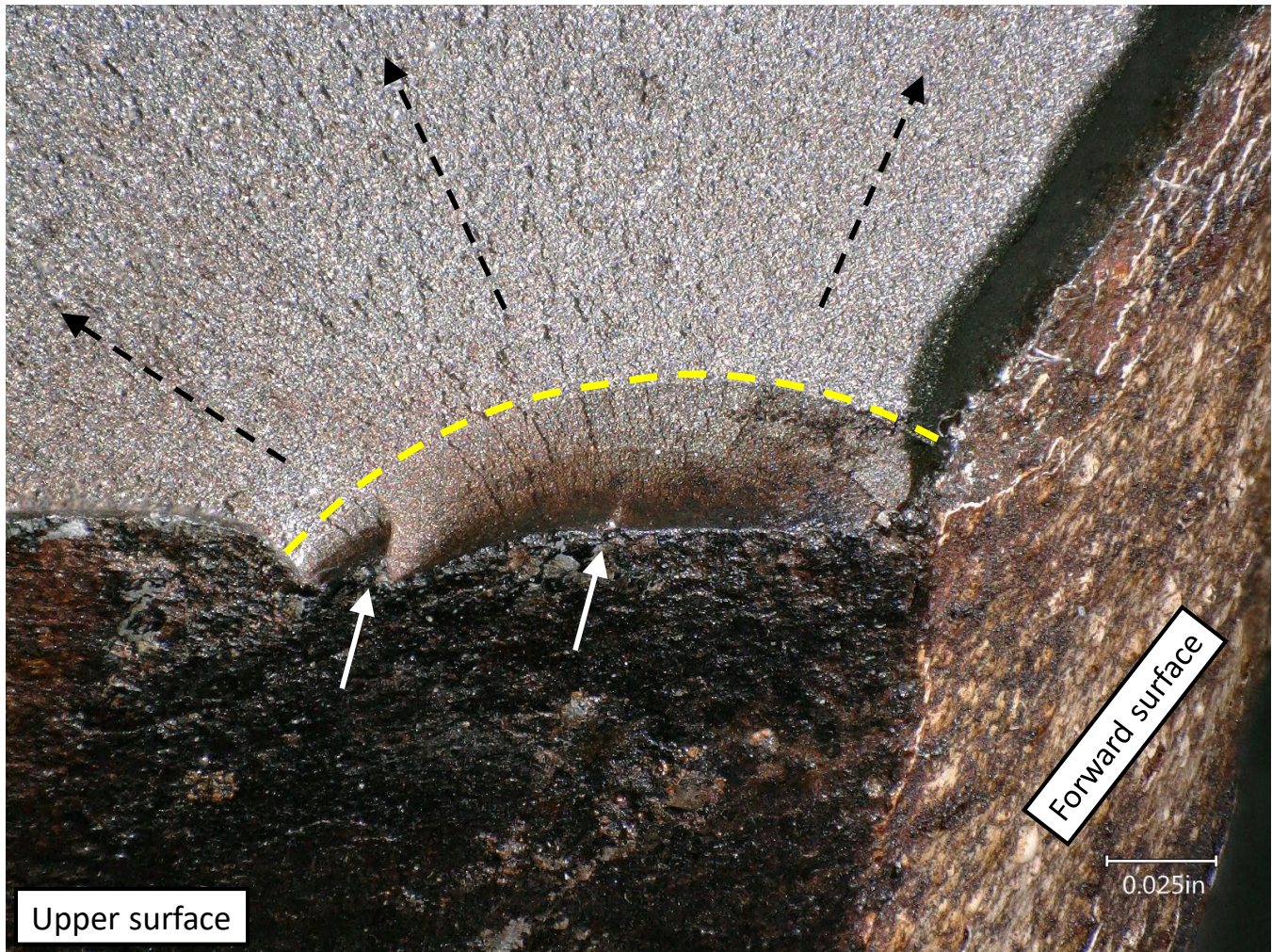


Figure 3: A digital microscope image of the fracture origin and adjacent surface. The yellow dashed line indicates the boundary of the thumb-nail shaped fatigue crack. White arrows highlight ratchet marks consistent with multiple crack origins on the upper surface within an area exhibiting corrosion. Black dashed arrows indicate crack propagation direction in the overstress region and shear lips were observed immediately after the fatigue crack boundary on the part periphery.