NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

November 13, 2017

MATERIALS LABORATORY FACTUAL REPORT Report No. 17-076

A. ACCIDENT INFORMATION

Place	:	Charleston, WV
Date	:	May 5, 2017
Vehicle	:	Short Brothers SD3-30 (N334AC)
NTSB No.	:	DCA17FA109
Investigator	:	Adam Huray (AS-40)

B. COMPONENTS EXAMINED

Flaps actuator input lever shaft

C. DETAILS OF THE EXAMINATION

A portion of the flaps actuator was submitted with the input lever shaft fractured. The fractured shaft is indicated by the red arrows in Figure 1. The fracture surface on the shaft was flat, and was approximately perpendicular to the longitudinal axis of the shaft, as shown in Figure 2. The fracture occurred through a portion of the shaft with a reduced diameter. The reduced diameter was the result of a machined step visible on the shaft (white arrows, Figure 2), which was consistent with a shear section specified on the manufacturer drawing.

The black bracket in Figure 2 indicates a wear scar around the circumference of the shaft outer diameter (OD), just below the fracture surface. The band appeared shiny, which contrasted with the opaquer appearance of the original manufacturing finish of the shaft visible adjacent to the fracture surface and at the base where the shaft mated with the bracket.

The fracture surface was examined using a 5x to 50x digital zoom microscope. The fracture surface was relatively flat, with smearing damage observed on large portions, as shown in Figure 3. The fracture surface was then examined using a Zeiss Auriga field emission (FE) scanning electron microscope (SEM), as shown in Figure 4. The smearing damage on the fracture surface obscured most of the finer features, but areas with microvoid coalescence were observed on undamaged portions of the fracture surface. The microvoids were elongated, which is consistent with shear overstress. The directionality of the microvoids, indicated by the black dashed line in Figure 4, followed the radial geometry of the shaft, which is consistent with shear overstress due to torsion.

The wear scar was also examined in the SEM, as shown in Figure 5. Smearing damage was visible on the shaft OD adjacent to the machined step. The smearing damage had a circumferential pattern, indicated by the black dashed line in Figure 5, which is consistent with torsional movement of the shaft.

The shaft was removed from the mating bracket and is shown in Figure 6. Damage was observed on the through hole for the locking pin. The hole was elongated at a roughly 45-degree angle from the longitudinal axis of the shaft. The hole was elongated on both sides of the shaft (white arrows, Figure 6), and the elongation was on opposite sides of the hole, which is consistent with a torsional motion of the shaft.

The shaft was analyzed using a Thermo Scientific Niton XL3t-980 x-ray fluorescence (XRF) alloy analyzer. The results were consistent with an aluminum alloy in accordance with QQ-A-225/6 as specified by the manufacturer.

Adrienne V. Lamm
Materials Engineer

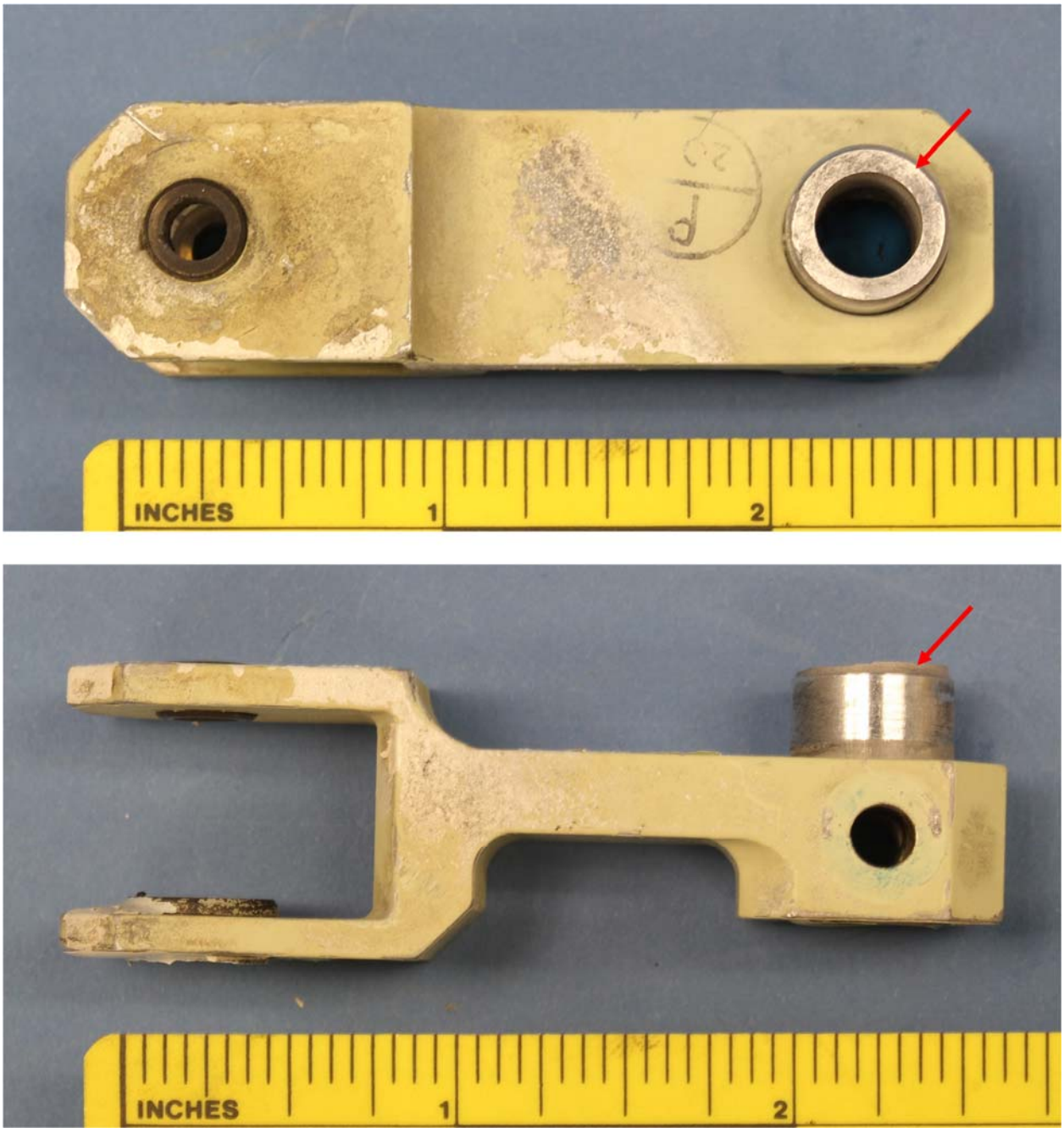

Figure 1: Overall photos showing the (top) fracture surface on the shaft and (bottom) profile of the shaft. The red arrows point to the fracture surface.

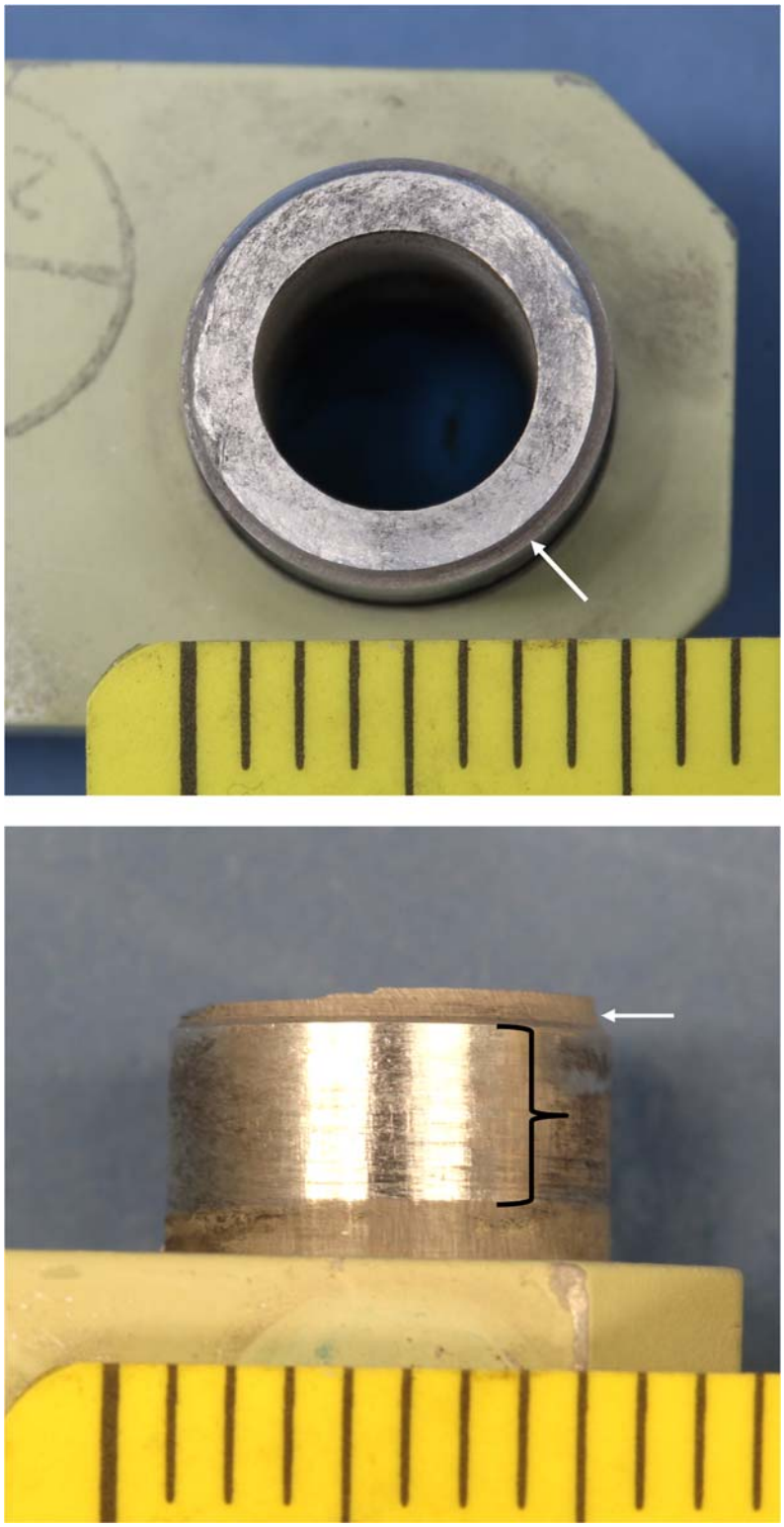

Figure 2: Close-up photos showing the (top) fracture surface on the shaft and (bottom) profile of the shaft. The white arrows point to the machined step on the shaft. The black bracket in the bottom photo indicates the shiny wear scar on the shaft OD.

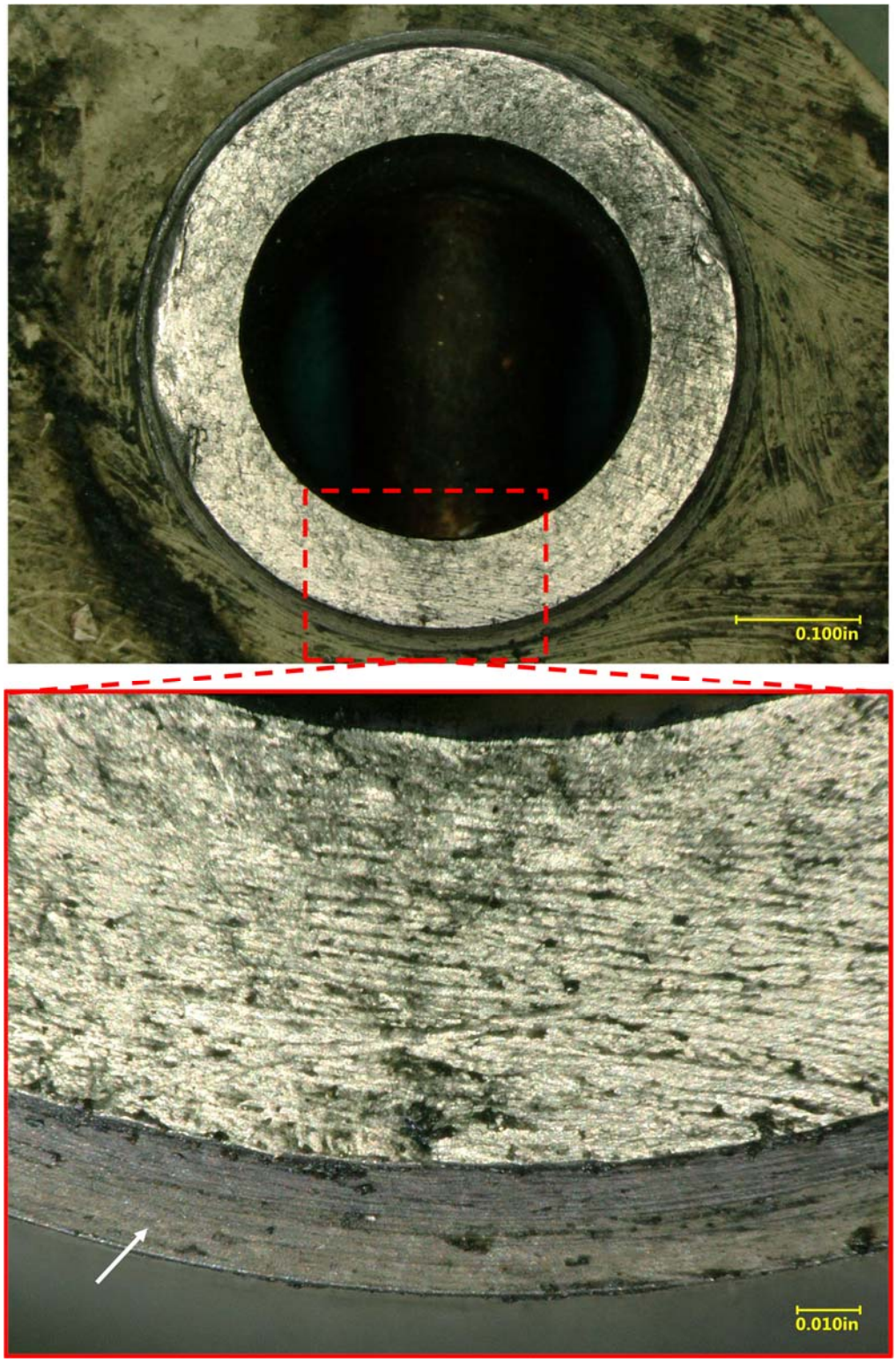

Figure 3: Digital microscope images of the fracture surface on the shaft. The white arrow in the bottom image points to the machined step on the shaft.

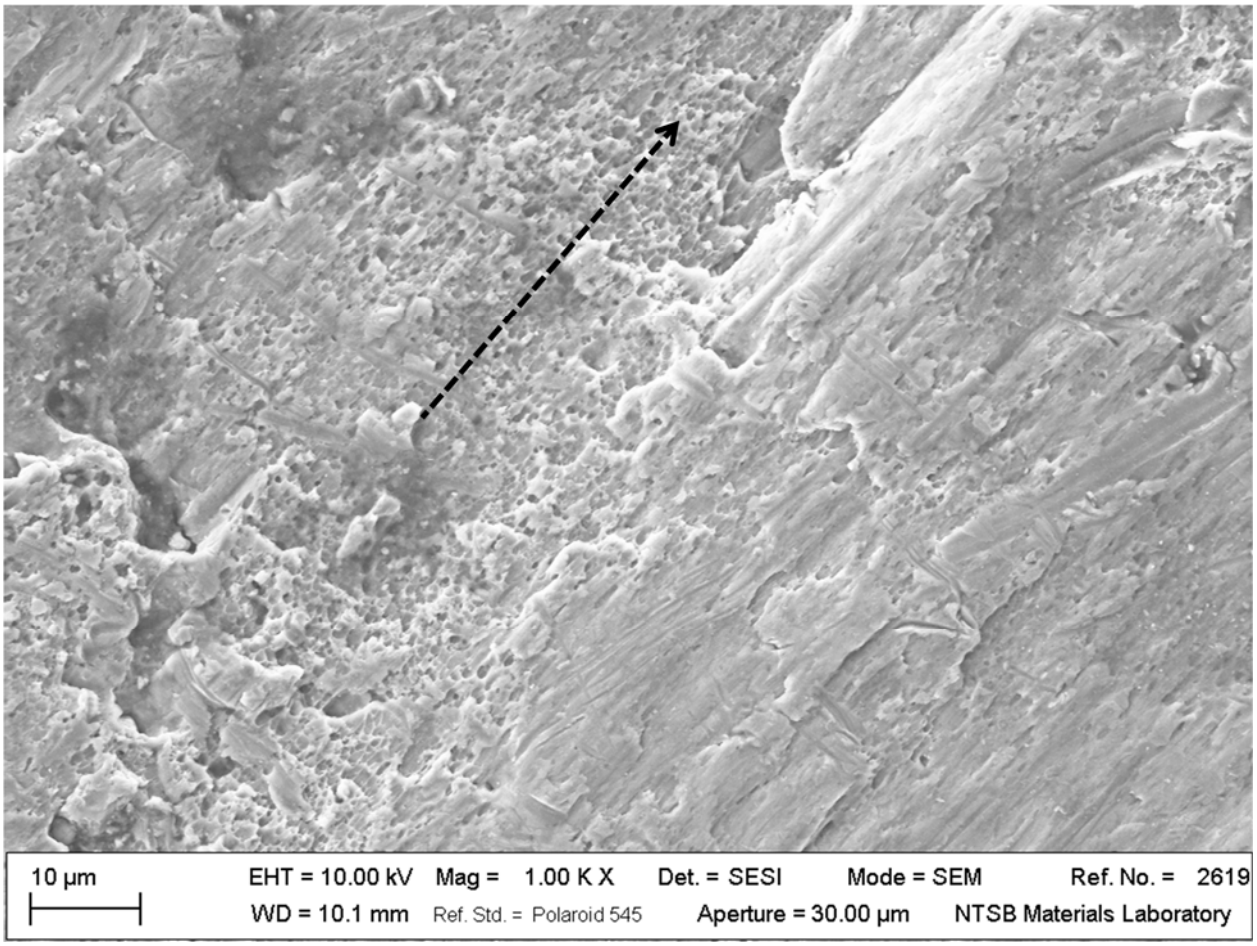

Figure 4: Secondary electron SEM image of the fracture surface on the shaft. The black dashed line indicates the directionality of the microvoids observed on an undamaged portion of the fracture surface.

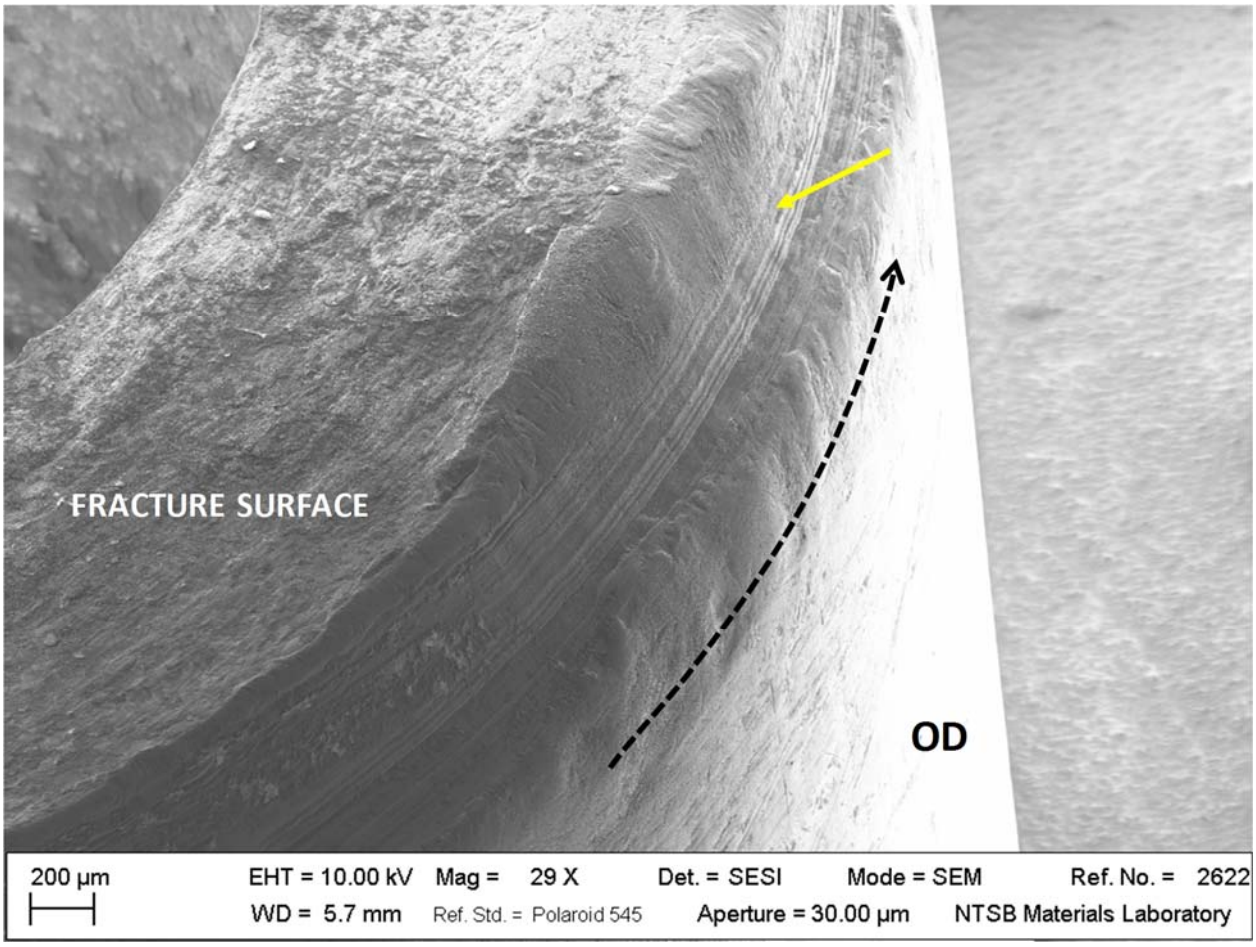

Figure 5: Secondary electron SEM image of the fracture surface on and the adjacent OD of the shaft. The yellow arrow points to the machined step on the shaft. The black dashed line indicates the circumferential directionality of the smearing damage on the shaft OD.

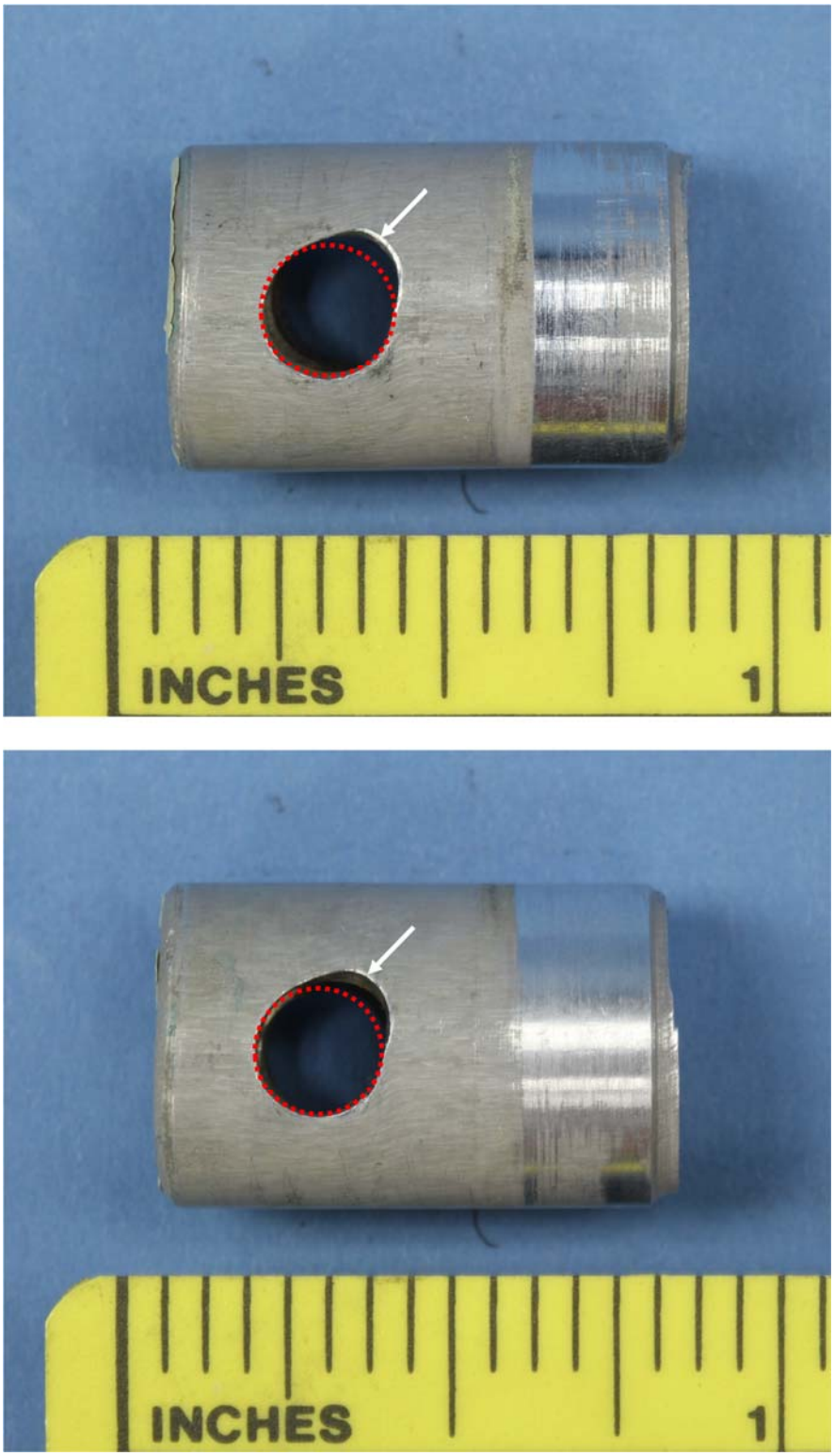

Figure 6: Close-up photos showing opposite sides of the separated shaft. The red dotted lines illustrate a perfect circle, while the white arrows point out elongation of the through hole in the shaft.