

NATIONAL TRANSPORTATION SAFETY BOARD

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



August 19, 2022

MATERIALS LABORATORY FACTUAL REPORT

Report No. 22-060

A. ACCIDENT INFORMATION

Place : Farmington, Connecticut
Date : September 2, 2021
Vehicle : Cessna 560XL, N560AR
NTSB No. : ERA21FA346
Investigator : Thomas Jacky, AS-40

B. COMPONENTS EXAMINED

Pieces of a parking brake cable assembly, P/N: 67-2531-2019.

C. DETAILS OF THE EXAMINATION

Pieces of a parking brake cable assembly were submitted to the NTSB Materials Laboratory for examination as shown in figure 1a. The assembly was a Bowden cable-type design with an outer housing and an inner actuated cable. The inner cable was actuated by a panel-mounted and crew-operated push/pull rod. The rod was equipped with a knob at one end and was connected to a swivel seal at the other end. The swivel seal was joined to the inner cable and a clevis fitting was joined to the cable at its opposite end. Most of the cable housing consisted of wires laid helically over a cylindrical core. Near the push/pull rod, the housing transitioned to a solid sleeve. The sleeve guided and centered the rod at the rod-to-cable transition. The sleeve was threaded at one end so that it could be attached to a sheet metal panel by sandwiching the panel between two nuts threaded onto the sleeve.

The sleeve had fractured in the threaded region as shown in figure 1b. The sleeve was bent, as was the wire cable housing where it met the sleeve. The push/pull rod was bent at the point where it entered the sleeve and otherwise exhibited no additional notable bends or nicks. The cable assembly had been cut in the field at one location and was separated at two additional locations, as indicated in figure 1a. The cable assembly between the two separated ends was not recovered and therefore was not examined. One separated end, shown in figure 2a, exhibited plastic crushing of the housing's cylindrical core, bending of the housing's wires adjacent to the fractured ends, transverse rub marks on several inner cable wires, and transverse elongation of several inner wires, all in the same direction (nominally top to bottom in figure 2a). The other separation, shown in figure 2b, exhibited transverse rub marks on the inner and outer fractured wire ends. The features were consistent with shear overstress fractures for both separations.

The fractured sleeve is shown in figures 3a and 3b prior to cleaning. The fracture through the sleeve initiated at thread roots and exhibited a rough appearance at an inclined angle, consistent with an overstress fracture. Inside the sleeve, the side leading to the push/pull rod and knob, shown in figure 3a, contained a rubber O-ring surrounding a fractured stub (part of the swivel seal). The other end, connected to the inner cable as shown in figure 3b, contained a flat disk of material (also part of the swivel seal as indicated below).

The fracture surfaces were cleaned with an alkaline detergent, a nylon brush, and a sonicating bath, in accordance with standard laboratory procedures. The rubber O-ring was removed with a pair of tweezers and the knob was pulled to try and remove the rod assembly from the sleeve, but it jammed before clearing the opening. With the rod pulled out as far as possible, the bent section of the sleeve (approximately 5/8" from the fractured end) was cut using a thin-kerf abrasive blade and the rod was pushed forward revealing the rod end and the fractured swivel link, as shown in figure 4. The swivel link consisted of two large-diameter sections separated by a small-diameter section within which the O-ring had been situated. The link had fractured at the transition from the small-diameter section to one of the large-diameter sections. The end of the rod and the swivel link were bent. The swivel link fracture surfaces, shown in figures 5a and 5b, exhibited radial lines emanating from an origin area along the outer bend and ending in a shear lip at the inner bend. The deformation and fracture features exhibited by the sleeve, the rod, and the swivel link were consistent with a bending overstress fracture.

Donald Kramer, Ph.D.
Sr. Materials Engineer

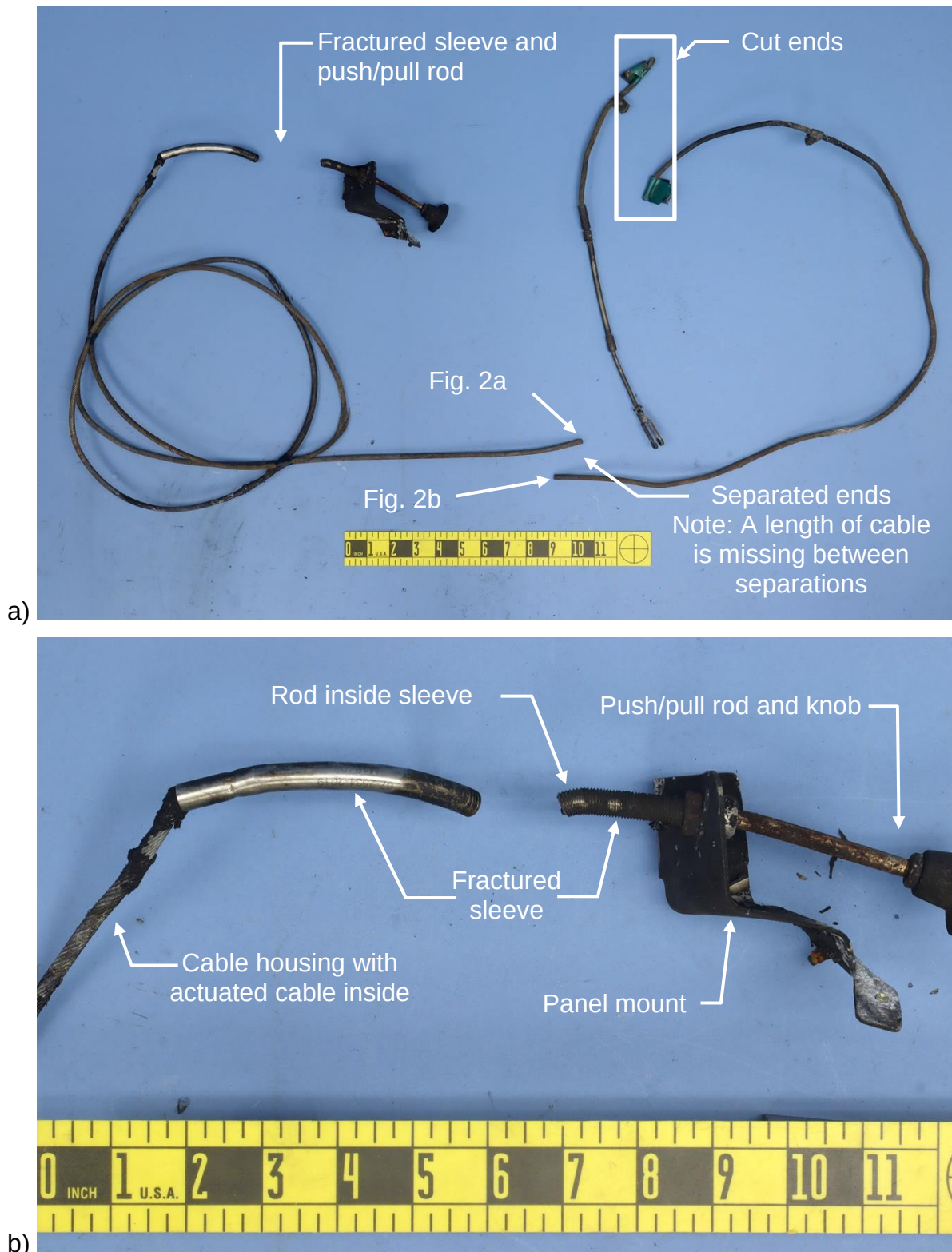


Figure 1: a) Pieces of the parking brake cable assembly as received and b) closer view of the fracture through the sleeve and the cable assembly adjacent to the push/pull rod and panel mount.

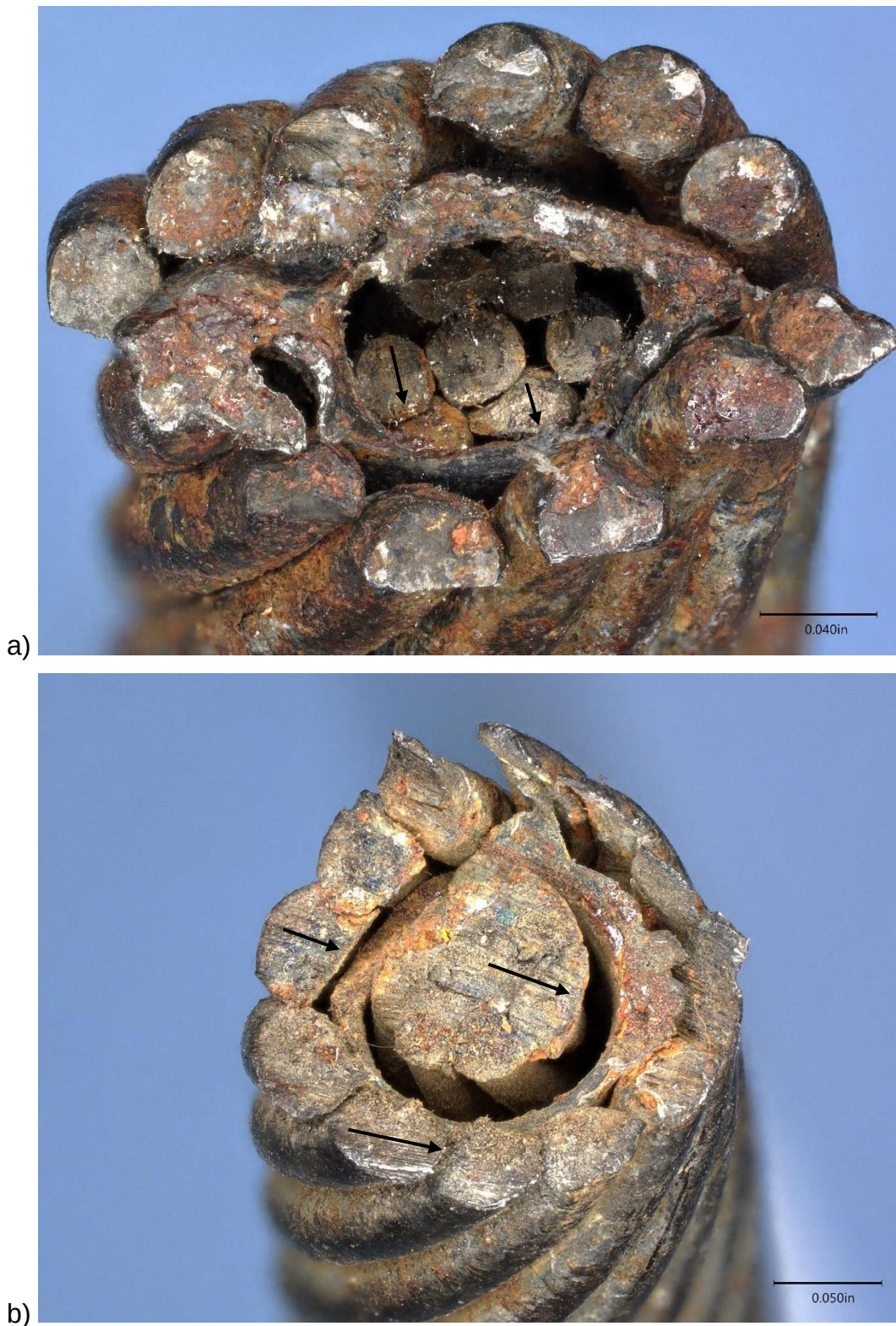


Figure 2: a) and b) Images of individual Bowden cable separations as indicated in figure 1a. Black arrows indicated directions of rub marks on the wire ends.



Figure 3: Images of the fracture through the sleeve and the inner cable assembly, as received; a) side connected to the pull rod and knob and b) side connected to the cable.

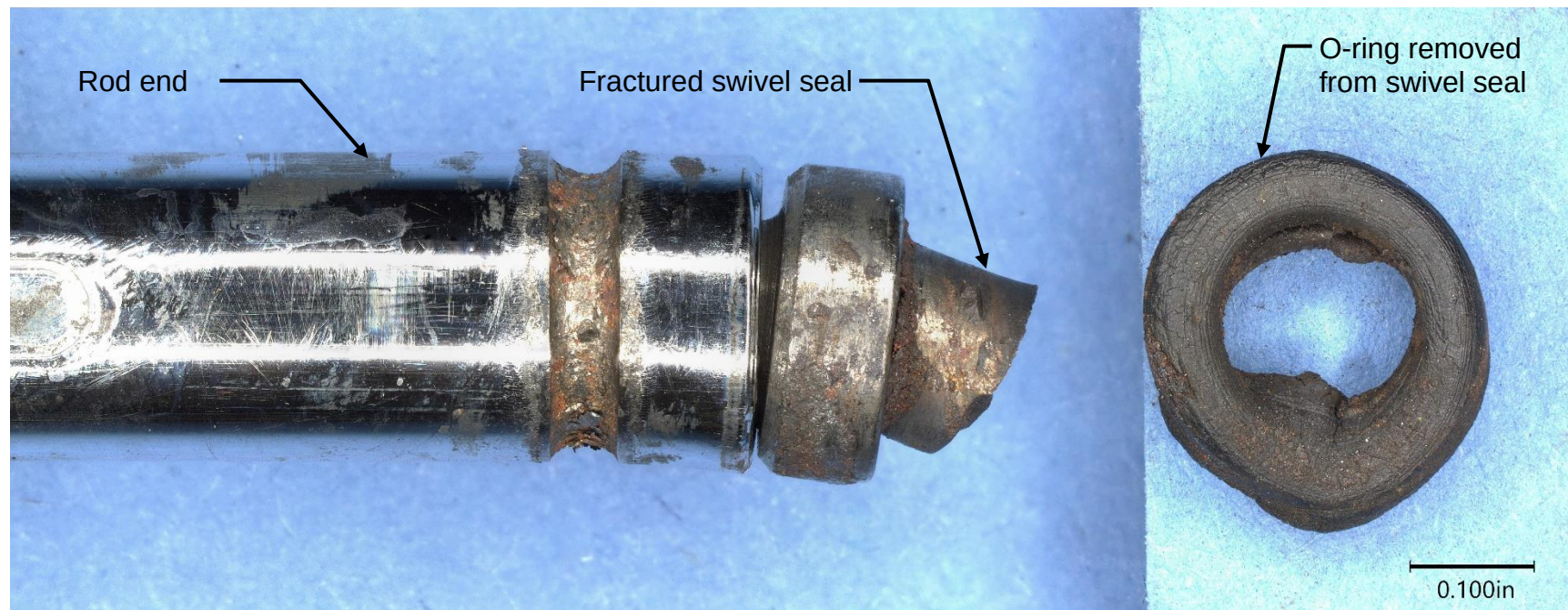


Figure 4: Image showing the push/pull rod, swivel seal, and rubber O-ring after sectioning the bent section of the sleeve.

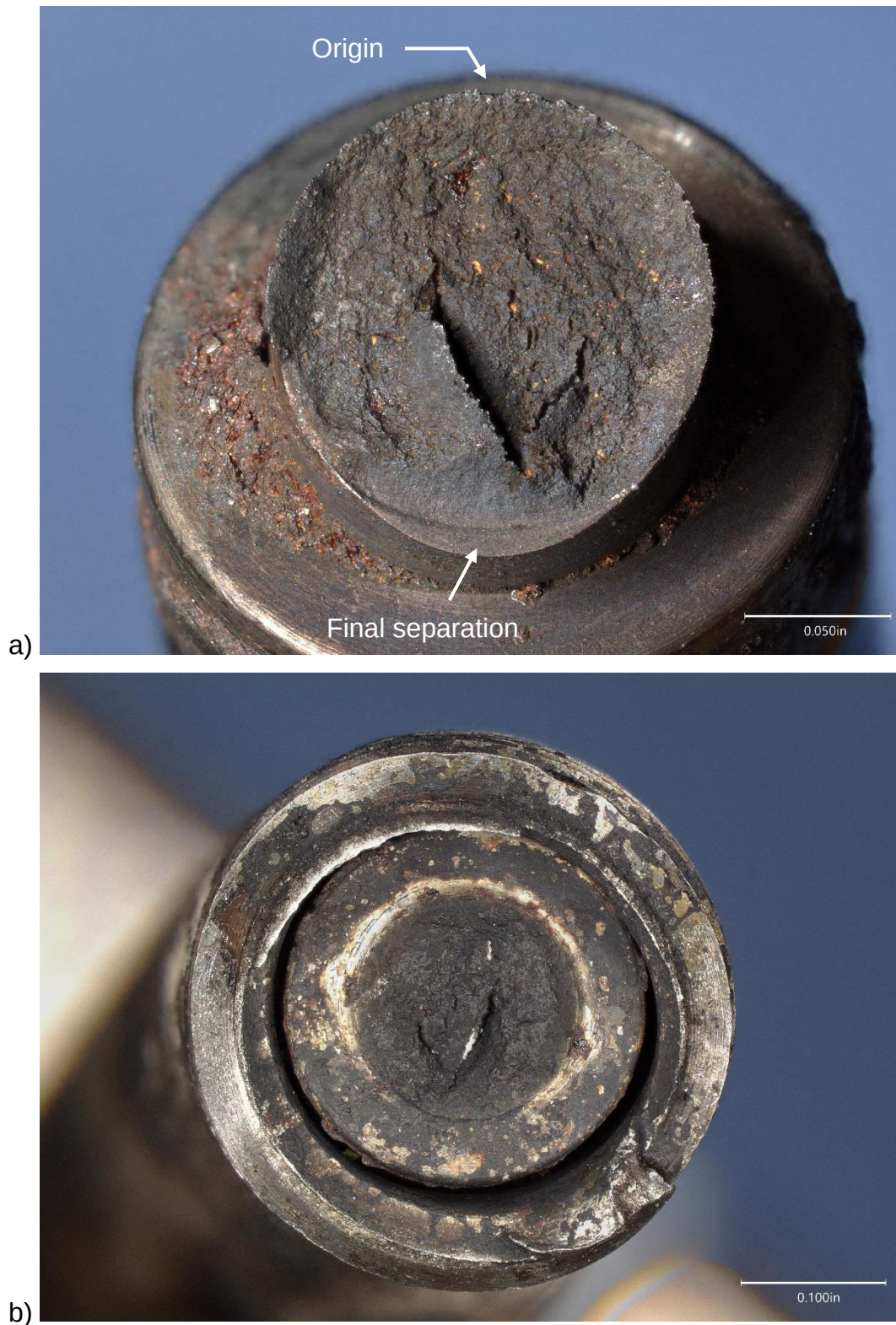


Figure 5: Images of the fracture through the swivel seal after disassembly and cleaning; a) push/pull rod and knob side and b) smooth-barrel sleeve and cable side.