

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR24LA038

MATERIALS LABORATORY

Factual Report 24-005

March 1, 2024

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A. ACCIDENT INFORMATION

Location: Yuma, Arizona
Date: November 17, 2023
Vehicle: Beech 95, N2024C
Investigator: Eric Gutierrez, AS-WPR

B. COMPONENTS EXAMINED

Rudder trim control rod end.

C. EXAMINATION PARTICIPANTS

Specialist Matthew R. Fox, Ph.D.
NTSB
Washington, DC

D. DETAILS OF THE EXAMINATION

An overall view of the submitted rudder trim control rod end with attached jam nut is shown in figure 1. The rod end was fractured through the threads approximately 3 to 4 threads away from the clevis end. The upper ear of the clevis was bent and twisted as shown in figure 1, and heavy contact damage was noted on the left side of the clevis and on threads between the clevis and the fracture surface. The clevis end was reportedly damaged during the process of disassembling it from the aft end of the trim control actuator rod end. A view of the rod end on the airplane before disassembly is shown in figure 2, where the attachment bolt is inserted through the apparently undeformed rod end clevis.

The aft side of the fracture was mostly obliterated by post-fracture damage, so additional examination focused on the forward (clevis) side of the fracture. An overall view of the clevis side of the fracture is shown in figure 3. A portion of the fracture surface on the left side had a more reflective appearance with a curving arrest line, features consistent with fatigue. The fracture features and curvature of the crack arrest lines were consistent with a broad origin area located at the left side of the fracture. Unlabeled arrows point to several crack arrest lines as the crack progressed through the cross-section. The first arrest line indicates the boundary of the relatively reflective region associated with fatigue. The middle portion of the fracture had rough, matte gray features consistent with ductile overstress fracture, and the second crack arrest line indicates a location where the upper side of the crack transitioned to the adjacent thread on the upper side of the fracture. A third arrest line was observed near the right side of the fracture as indicated with additional unlabeled arrows in figure 3. The remainder of the fracture on the right side had rough features with a more reflective appearance, and the outer edges of the fracture were deformed and smeared.

The fracture surface was further examined using a scanning electron microscope (SEM). SEM images of the fatigue region on the left side of the fracture are shown in figure 4. The fatigue features emanated from a broad origin area at the root of the thread and propagated preferentially along the thread root. Course striations and secondary cracking was observed at higher magnifications shown in the lower image in figure 4, features consistent with a relatively high-stress low-cycle fatigue fracture mechanism extending to the first crack arrest line shown in figure 3.

The middle portion of the fracture surface showed dimple features consistent with ductile overstress fracture up to the third crack arrest line indicated at the right side of the fracture in figure 3. To the right of the third crack arrest line, the fracture surface showed smeared dimple features shown in the overall SEM image of the right side of the fracture shown in figure 5. Closer to the right side, the smeared dimple features transitioned to flatter fracture features with coarse striations consistent with additional high-stress low-cycle fatigue crack propagation as shown by the lower image in figure 5. Smearing and deformation consistent with compressive contact damage was observed at the outer edge on the right and lower sides, contact damage that was not observed on the right side at the fatigue origin area.

Submitted by:

Matthew R. Fox, Ph.D.
Chief Technical Advisor - Materials

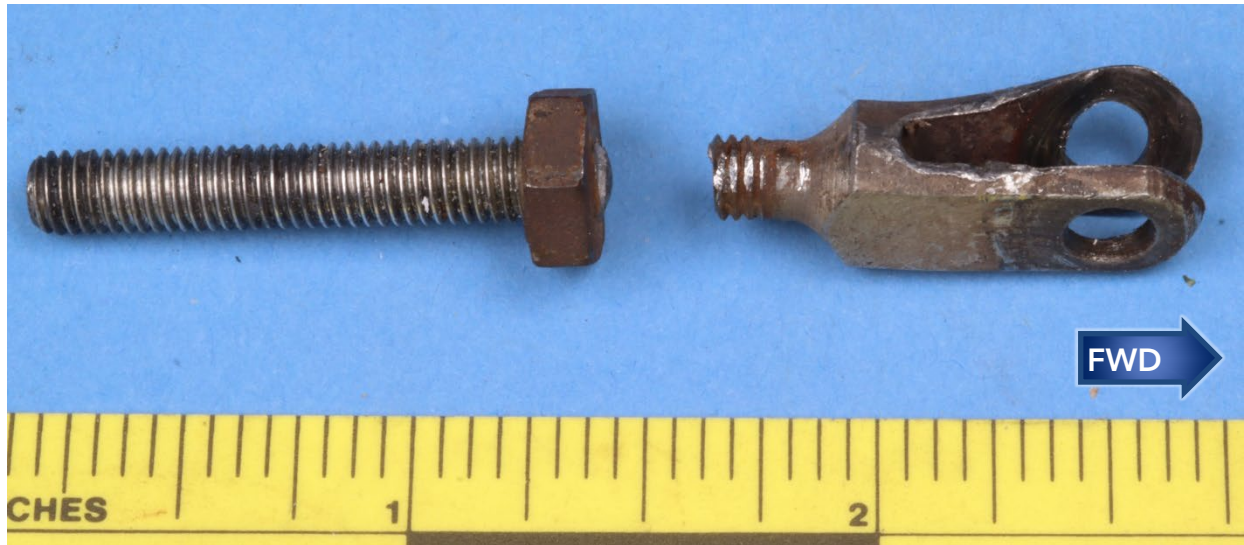


Figure 1. Overall views of the submitted rudder trim control rod end as received.

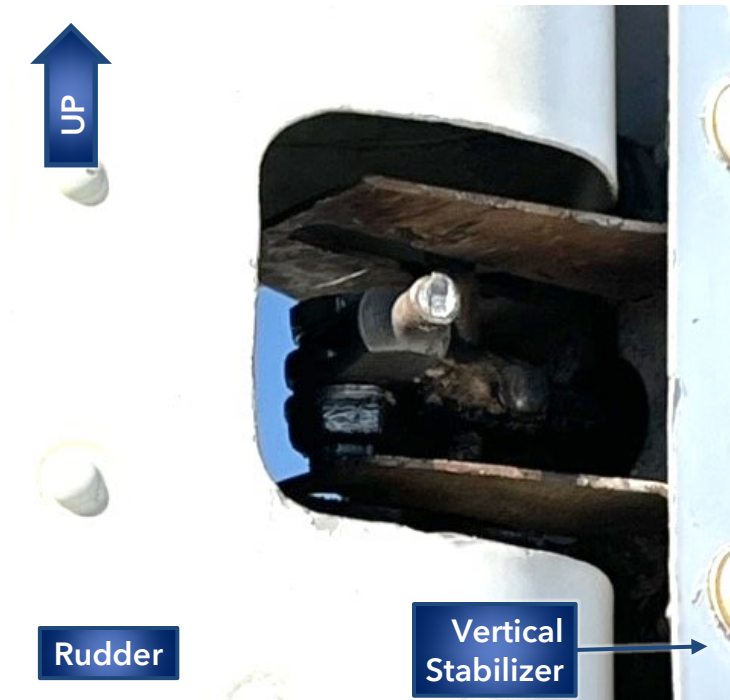


Figure 2. View of the right side of the rudder at the rudder leading edge showing the fractured rudder trim control rod end attached to the control actuator rod end before disassembly from the aircraft. (Image source: Federal Aviation Administration)

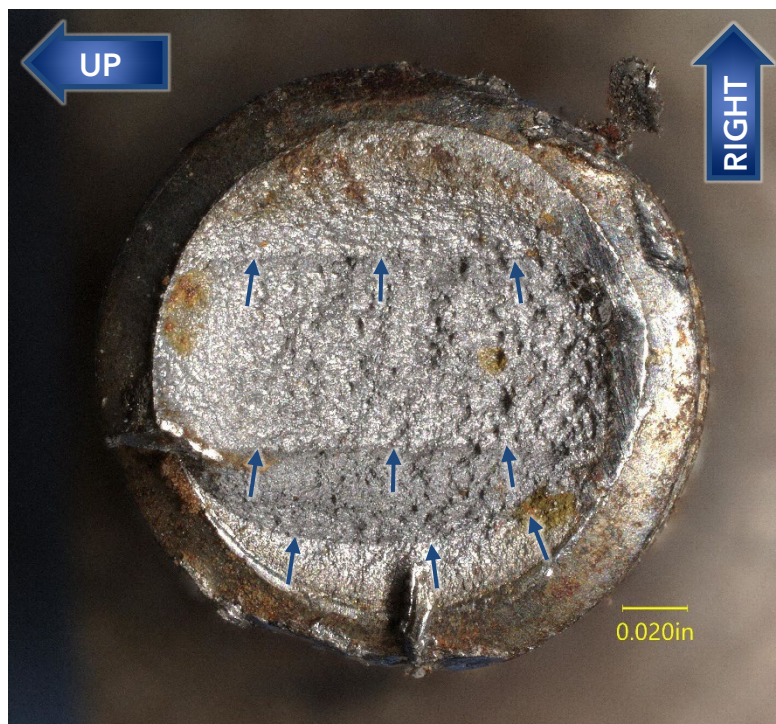


Figure 3. Optical image of the clevis side of the fracture. Unlabeled arrows indicate fracture progression marks.

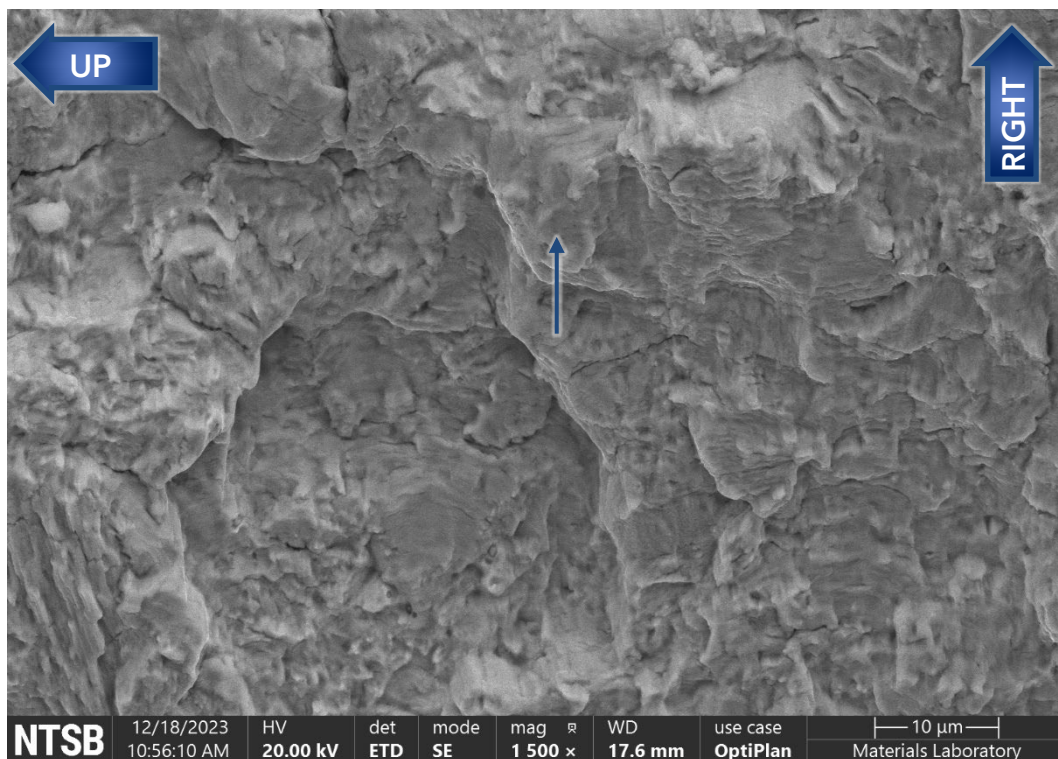
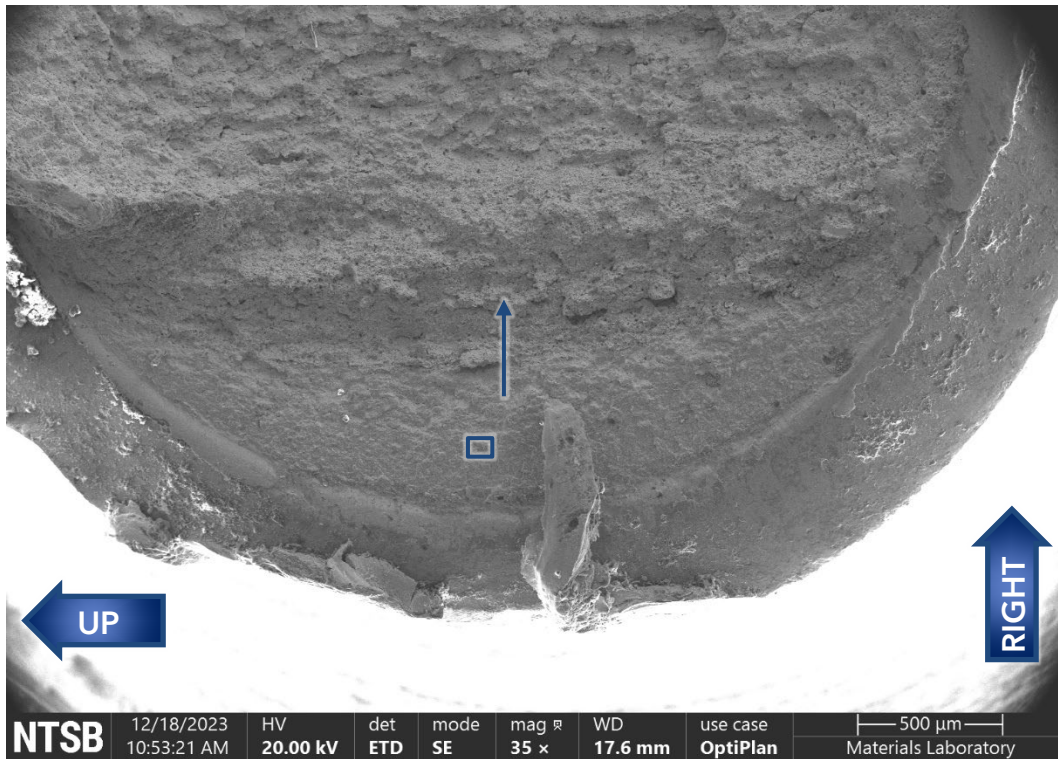


Figure 4. SEM image of the left side of the fracture (upper image) with a closer view of progressive fracture features near the origin area (lower image). The lower image shows features in the rectangular area marked on the upper image. Unlabeled arrows indicate the general fracture propagation direction.

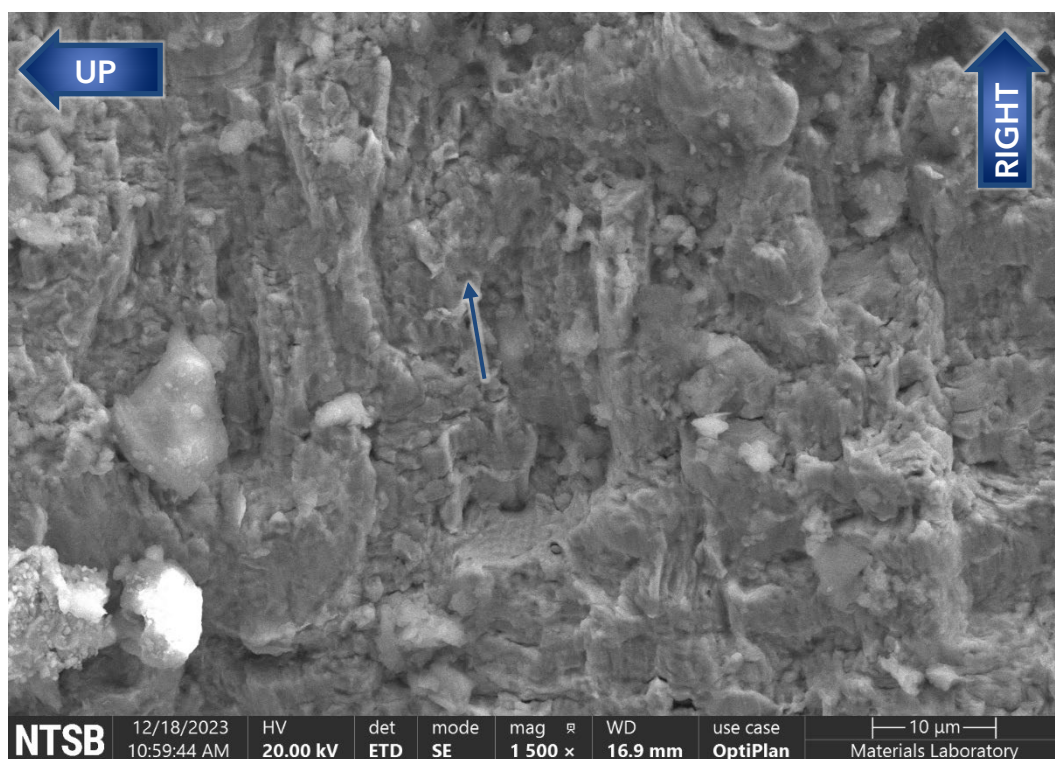


Figure 5. SEM image of the right side of the fracture (upper image) with a closer view of progressive fracture features near the right side of the fracture (lower image) in the rectangular area marked on the upper image. Unlabeled arrows indicate the general fracture propagation direction.