

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR23LA150

MATERIALS LABORATORY

Factual Report 23-046

May 25, 2023

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A. ACCIDENT INFORMATION

Location: Ashland, Oregon
Date: April 7, 2023
Vehicle: Compagnie Daher TBM 700, N6924G
Investigator: Scott Johnson, AS-WPR

B. COMPONENTS EXAMINED

Fuel control cable input rod end piece with end fitting.

C. EXAMINATION PARTICIPANTS

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

D. DETAILS OF THE EXAMINATION

An overall view of the submitted components are shown in figure 1. The fuel control cable input rod was fractured in the threads adjacent to the jam nut on the end fitting as indicated in the right image in figure 1. The input rod threads were visible within the witness hole in the end fitting consistent with sufficient thread engagement.

The fracture surface was mostly covered with oily deposits. The surface was initially cleaned using a soft-bristle brush dipped in a solution of Alconox detergent and water followed by rinsing with water then ethanol. Examination of the fracture surface using an optical stereomicroscope revealed relatively rough fracture features consistent with ductile overstress fracture. However, oily deposits were observed to bleed back onto the fracture surface following the examination.

To facilitate further examination of the fracture, the jam nut was loosened from the end fitting, and the input rod piece was unthreaded from the end fitting and jam nut. The fracture surface was then cleaned while submerged in acetone using an ultrasonic cleaner. The cleaned surface was then further examined using a scanning electron microscope (SEM).

A montage image of the fracture surface stitched together from multiple SEM images is shown in figure 2. Around the edges of the fracture, elongated dimples on a slant angle consistent with a shear lip were observed. In the middle of the fracture, cleavage fracture features were observed intermixed with dimple features such as the area shown in figure 3. Secondary cracks and fissures were also observed intersecting the fracture surface. All features were consistent with overstress fracture with no evidence of progressive fracture.

Using a slow-speed abrasive saw, two transverse cuts were made through the input rod piece adjacent to the fracture surface to prepare a transverse metallographic section while preserving the fracture surface. The transverse section was then mounted in a polymer mount along with the remaining threaded end piece, which was mounted lengthwise next to the transverse section. The metallographic specimens were then ground until the polishing plane was close to the middle of the longitudinal section, and the sample was polished and etched using 2% nital. A view of the longitudinal section is shown in the left image in figure 4. The microstructure consisted of ferrite and pearlite that was elongated into a banded structure along the longitudinal axis. The microstructure was deformed around the thread profile consistent with rolled threads. The microstructure in the transverse plane is shown at higher magnification in the right image in figure 4, where the pearlite appears brown, and ferrite appears white.

Superficial hardness was measured on the metallographic specimens using a Rockwell indenter set to operate on the HR30N scale. Two indents were made in the longitudinal plane, and one indent was made in the transverse plane. The average hardness measured 48.0 HR30N, which corresponds to a hardness of 27.3 HRC. A steel with that hardness has an estimated tensile strength of 129,000 pounds per square inch.¹

Submitted by:

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

¹ ASTM A370-12a, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*, ASTM International, West Conshohocken, Pennsylvania (2012).

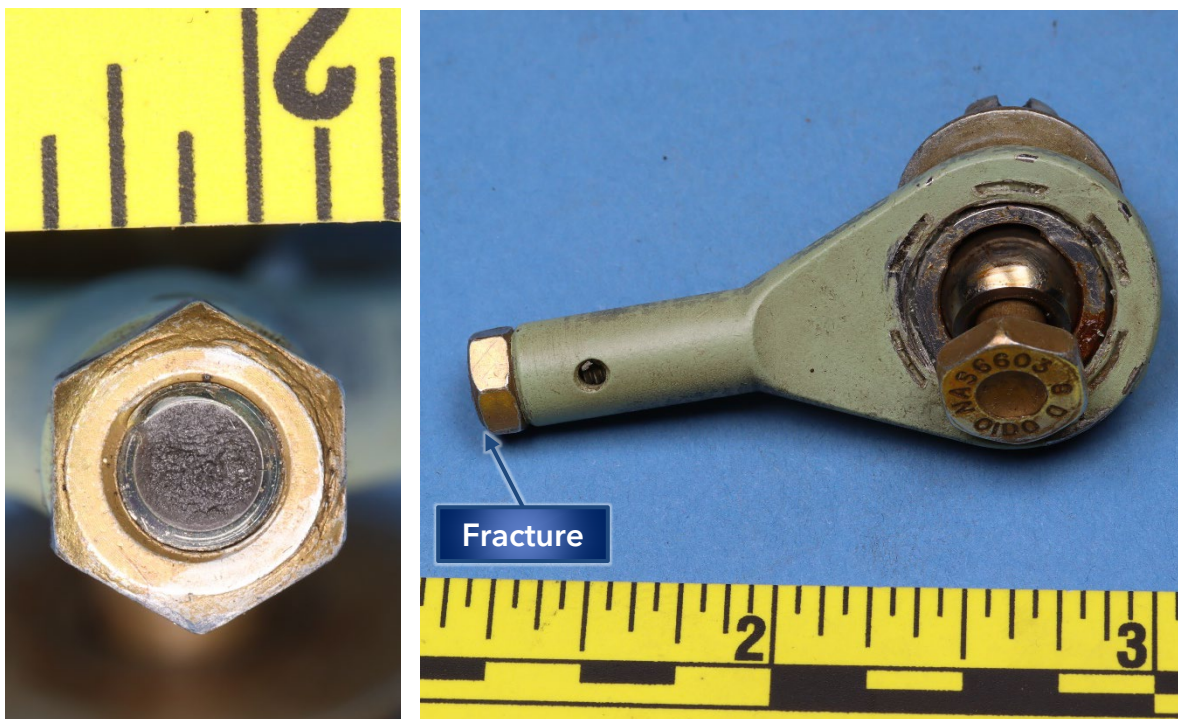


Figure 1. Overall view of the end fitting (right image) and fracture surface of the control cable input rod (left image) as received.

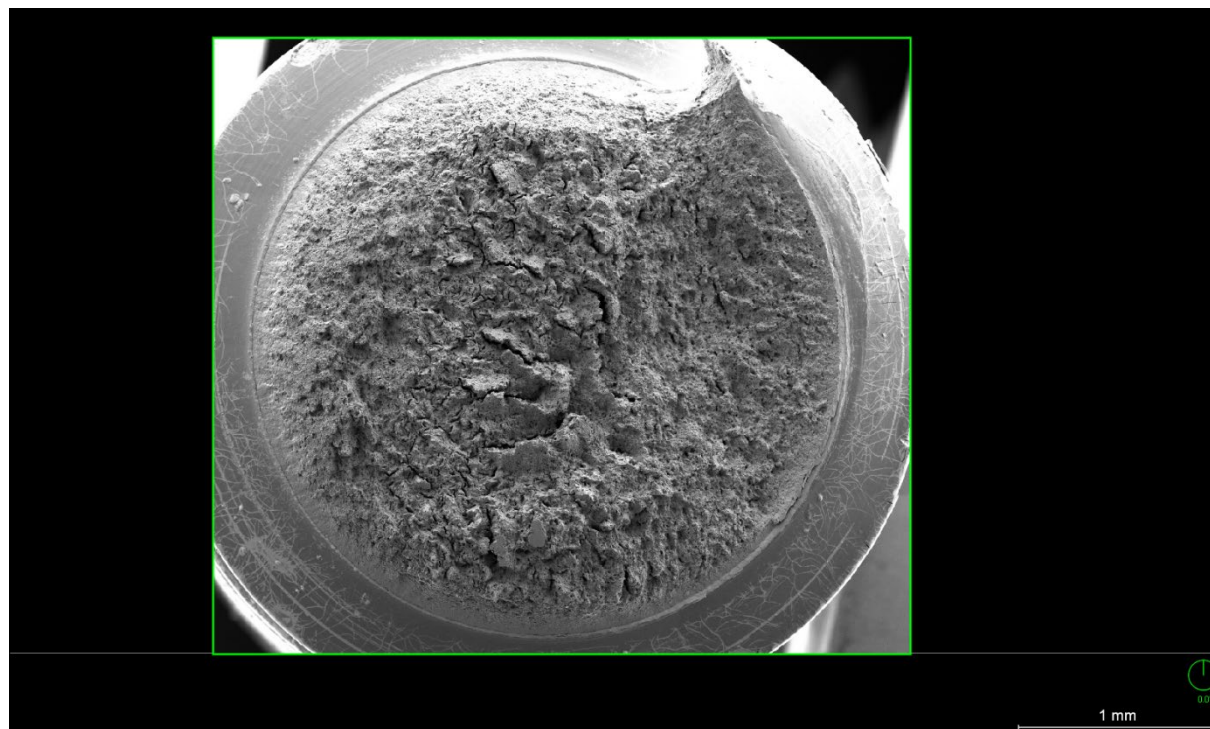


Figure 2. Montage of SEM images stitched together to show an overall view of the fracture surface after cleaning.

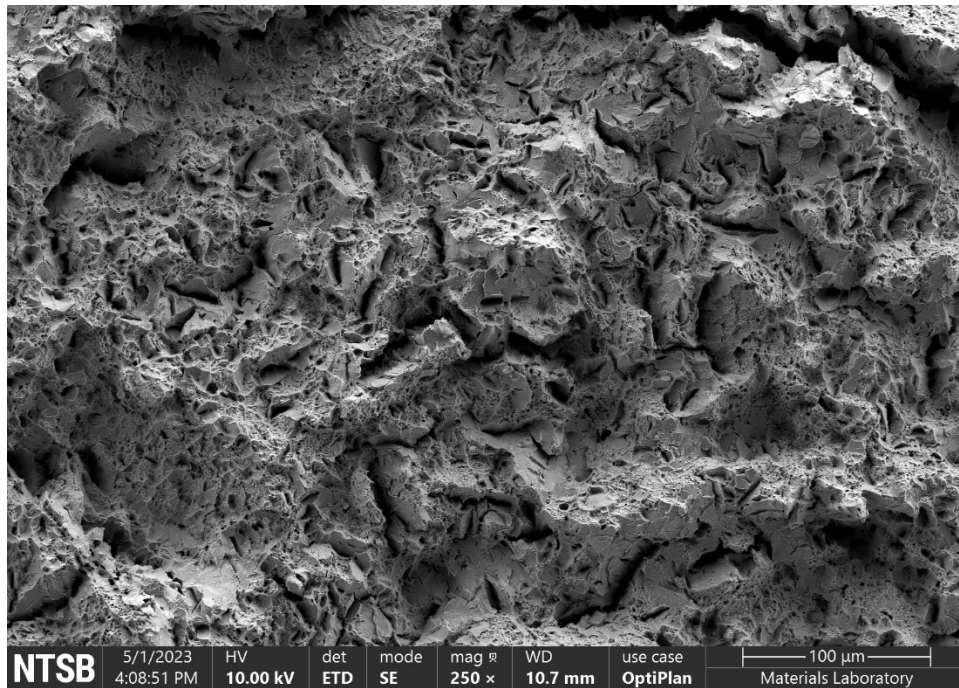


Figure 3. SEM image of typical features observed near the middle of the fracture surface.

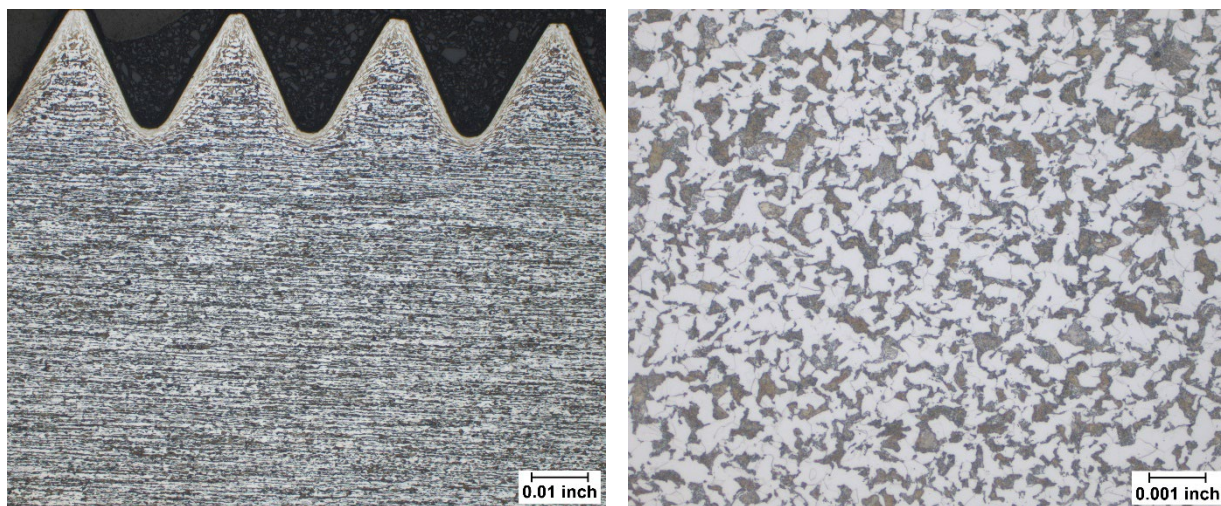


Figure 4. Banded microstructure consisting of ferrite and pearlite with rolled thread profiles observed in the longitudinal cross-section (left image). The ferrite (white) and pearlite (brown) microstructure are shown at higher magnification in the transverse cross-section (right image). Both images are brightfield optical micrographs shown after etching with 2% nital.