National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

ERA23LA041

MATERIALS LABORATORY

Factual Report 23-031

March 29, 2023

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A. ACCIDENT INFORMATION

Location: Lordstown, Ohio
Date: October 23, 2022
Vehicle: Rhinehart Stolp SA-300, N160JR
Investigator: Brian Rayner, AS-ERA

B. COMPONENTS EXAMINED

Piece of elevator trim control cable and trim control cable attachment bracket with associated hardware removed from the trim tab.

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 aft end of the elevator trim control cable was separated from the attachment bolt on the corresponding attachment bracket. The forward end of the cable piece had been cut from the remainder of the cable, and a clamp remained attached next to a bend in the cable. The trim control cable attachment bracket had been disassembled from the trim tab, and the attaching hardware remained loosely assembled on the bracket. Hardware for attaching the cable to the bracket was intact on the bracket, which was also intact.

Sliding contact marks were observed on the surface of the cable near the aft end as indicated with a bracket in figure 2. The cable was rotated from the view in figure 1 by lifting the forward end of the piece off the table toward the camera to orient the sliding contact marks to face the camera in figure 2. As evident in this view, the sliding contact marks were located on a side of the cable that was closer to the inside radius of the bend.

A closer view of the elevator trim control cable attachment hardware on the bracket is shown in figure 3. The hardware consisted of a bolt, nut, and spacer. The hat-shaped spacer consisted of a larger-diameter “brim” and a smaller-diameter “body”. The spacer moved freely on the bolt grip between the bolt head and the nut, and the body slid easily into a hole for the spacer body in the bracket. The side of the spacer body was worn as indicated in figure 3 consistent with contact with the corresponding hole in the bracket.

The spacer body was slid into the hole in the bracket until the spacer contacted the nut, revealing a through-hole in the shank under the bolt head as shown in figure 4. The spacer and bracket were then moved toward the bolt head, revealing the bolt shank adjacent to the clamping face of the nut. Only the smooth grip portion of the bolt shank was revealed, and no exposed threads were observed adjacent to the nut clamping face.

Next, the bolt threads and the nut were marked in ink as indicated in figure 3 to note the relative positions of the nut and the bolt. Before disassembling the cable attachment hardware, the nut was initially rotated in the tightening direction. The nut rotated about 10 degrees, and the rotation was stopped due to rapidly increasing resistance. The nut was then removed from the trim control cable attachment bolt to facilitate further examination of the bolt and the cable contact faces on the spacer. On the bolt, the thread runout area adjacent to the grip appeared rubbed consistent with contact with the nut threads.

The spacer surfaces were partially covered with greasy black deposits. After an initial examination under an optical stereomicroscope, the spacer was dipped in a beaker of acetone and cleaned using an ultrasonic cleaner. A view of the cleaned contact faces of the spacer is shown in figure 5. The image shown in figure 5 is a montage of obtained in shadow mode and stitched together using a Keyence VHX-7000 optical microscope.

As shown in figure 5, multiple impressions were observed around the circumference of the contact face consistent with cable contact from multiple assembly positions. All but two of the impressions had relatively smooth surfaces consistent with static contact with the cable. The two impressions as indicated with arrows in figure 5 had radially-oriented sliding contact marks consistent with the cable sliding against the spacer. The two impressions with sliding contact marks were located on opposite sides of the spacer, consistent with a single installation position.

Following the examination of the spacer, the nut was reassembled onto the trim control cable attachment bolt without the spacer. The nut had a locking function, and some running resistance was felt as the locking function engaged. Using the ink reference marks previously marked on the bolt and the nut, the nut was turned to within ¼ turn of aligning the reference marks on the bolt and the nut. The torque required to move the nut to align the marks was then measured using a PCB Piezoelectronics (Depew, New York) Load and Torque Model 962 Recorder with a rotary torque angle transducer having 1 pound inches to 20 pound inches capacity. The torque required to complete the ¼ turn to align the reference marks ramped up quickly, leading to a peak of 7.5 pound inches when the reference marks aligned.

Using calipers, the distance between the nut clamping face and the bolt head was measured on each side of the bolt where the through-hole intersected the shank

circumference. The distance measured 0.191 inch on one side and 0.195 inch on the opposite side. The thickness of the spacer was measured using a point micrometer at the center of each cable contact impression with the sliding contact marks. The two spacer thickness measurements were 0.128 inch and 0.129 inch. The diameter of the elevator trim control cable was measured using a flat micrometer in two orthogonal directions near the aft end of the cable. The two cable diameter measurements were 0.0623 inch and 0.0624 inch.

Submitted by:

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

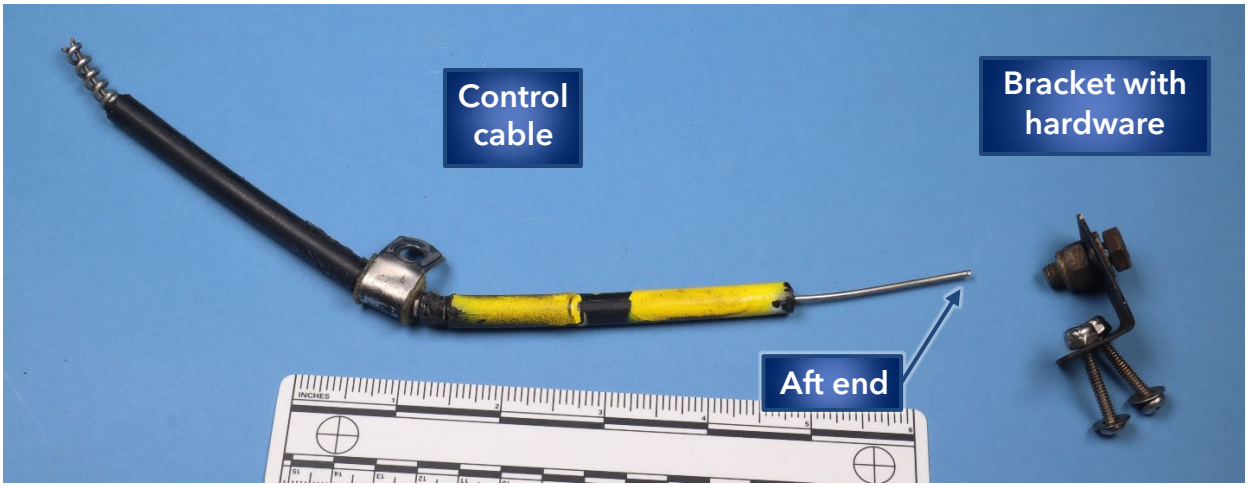

Figure 1. Elevator trim control cable piece and trim tab attachment bracket with associated hardware as received.

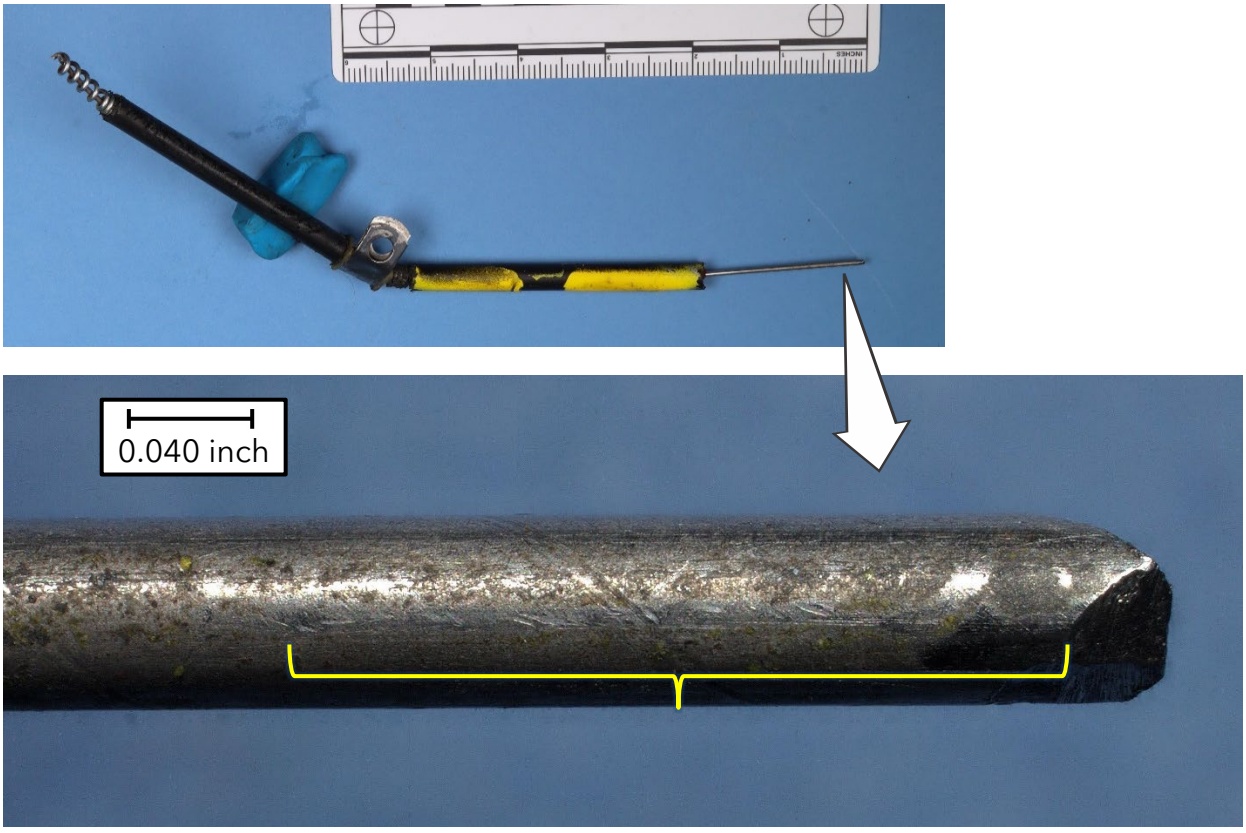

Figure 2. Another view of the aft end of the control cable piece (upper image) with a closer view (lower image) showing sliding contact marks as indicated with a bracket.

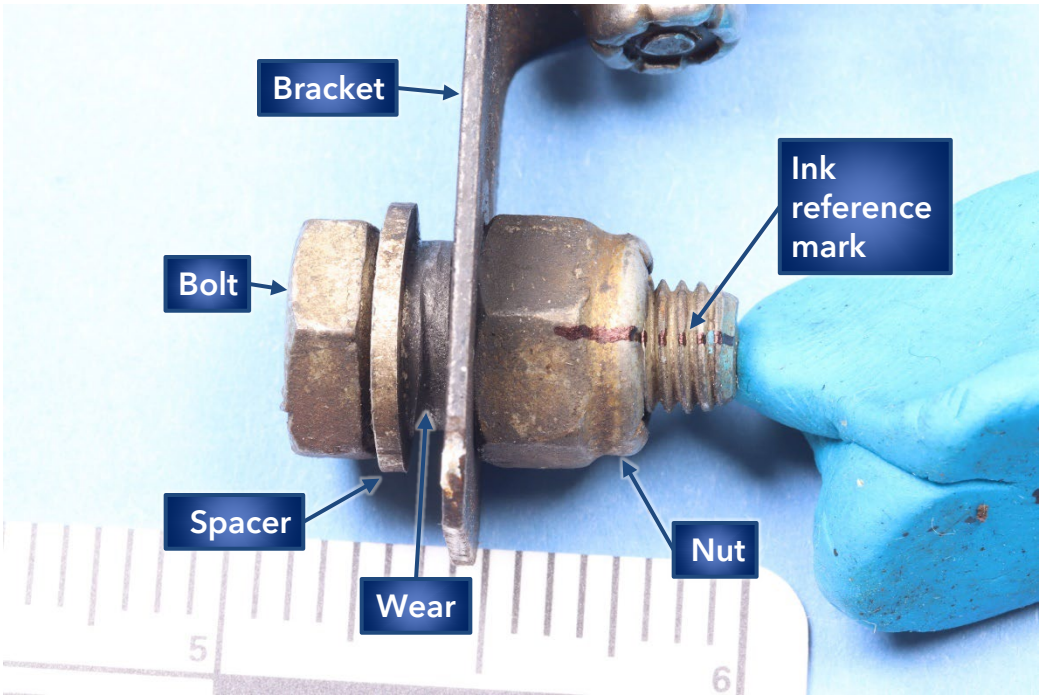

Figure 3. Close view of the trim tab control cable attachment hardware on the trim tab bracket.

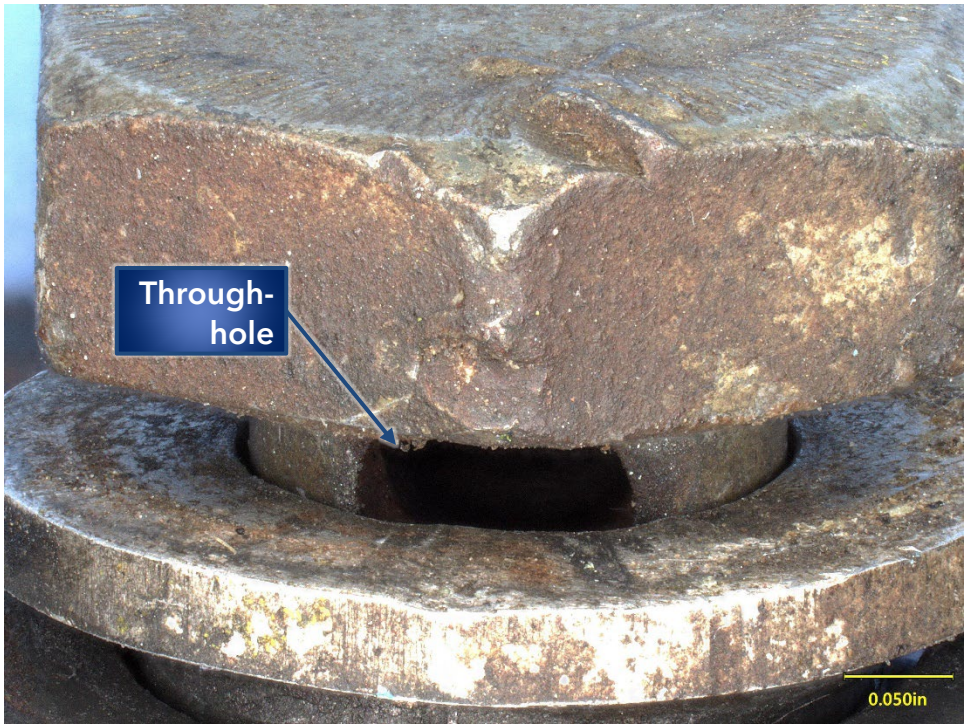

Figure 4. View of the through-hole in the shank of the trim tab attachment bolt with the spacer positioned against the nut.

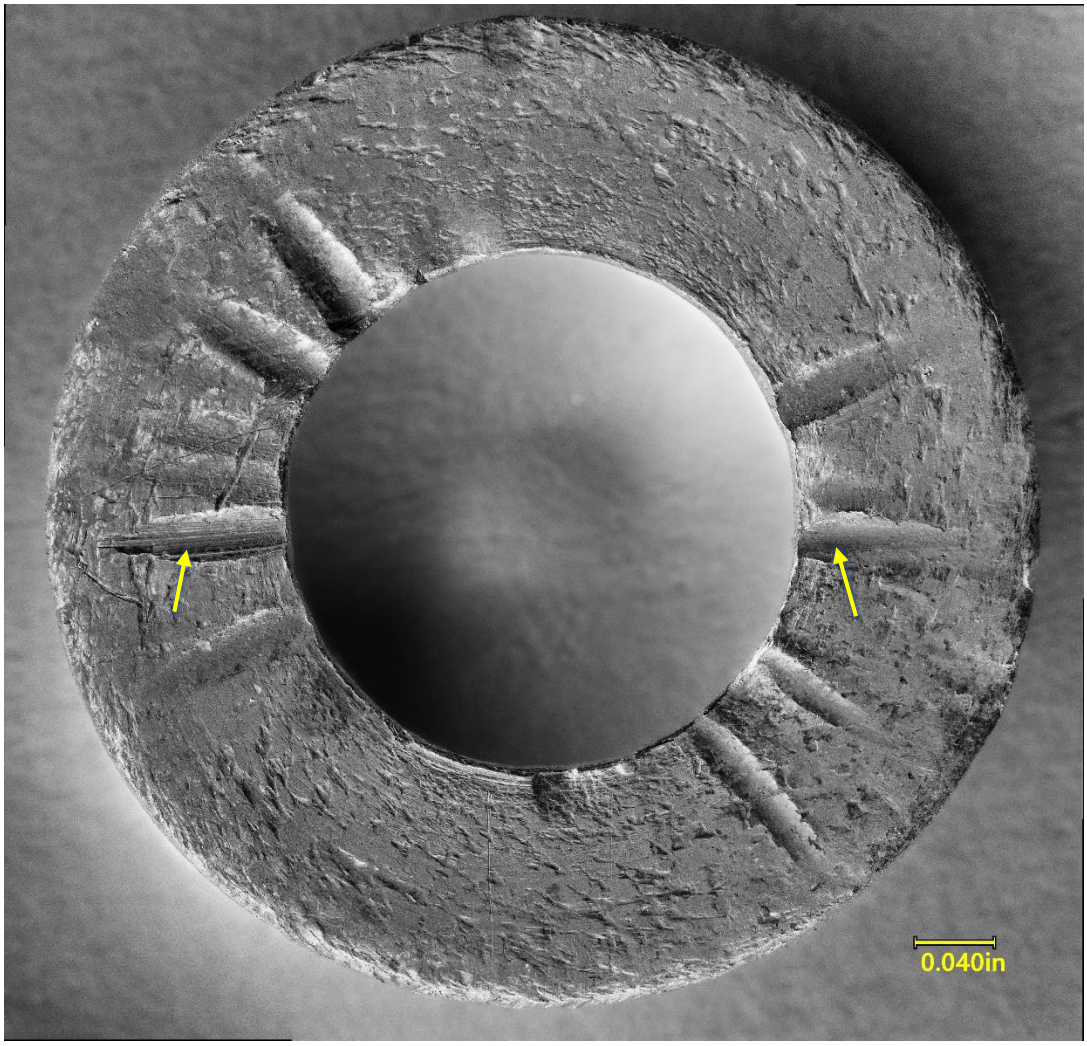

Figure 5. Elevator trim control cable contact face of the spacer after disassembly and cleaning obtained using a Keyence VHX-7000 optical microscope in shadow mode. Arrows indicate two impressions with sliding contact marks.