

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR24LA260

MATERIALS LABORATORY

Factual Report 25-037

June 9, 2025

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A. ACCIDENT INFORMATION

Location: La Grande, Oregon
Date: July 23, 2024
Vehicle: Kitfox Series V (N53562)
Investigator: Kristyn Blocher (AS-WPR)

B. COMPONENTS EXAMINED

Propeller hub containing one wooden propeller blade and one wooden blade separated from the hub assembly.

C. EXAMINATION PARTICIPANTS

Specialist Brian Fuchs
National Transportation Safety Board
Washington, D.C.

D. DETAILS OF THE EXAMINATION

Pieces of a ground-adjustable-pitch three-blade propeller assembly (GSC Systems) were submitted for examination at the materials laboratory (Figure 1). The components consisted of a metal three-blade-bore hub, two wooden propeller blades, and two blade roots that were retained by the hub. The blades were constructed of laminated wood with a black polymer cap (approximately 0.05 inch thick) covering the root of each blade. The grains of the laminate layers were oriented parallel to the length of the blade. The blade roots were installed in the hub, which consisted of two aluminum halves held together by hex head bolts. Each blade retaining lug of the hub contained two bolts (one on either side of the propeller blade). These bolts appeared to have been left in place post-accident. The center of the hub contained six bolts arranged in a circular pattern. Three of these bolts (alternating bolts in the circle) fed through machined holes in the roots of the blades, securing them into the hub. The remaining three bolts held the two halves together. The nuts on the six bolts from the hub center appeared to have been removed and then re-threaded onto the bolts. One identifying mark was found on the hub; the number "25" was stamped into the outboard end of one retaining lug.

As received, one blade was retained by the hub, one blade was separated from the hub, and the third blade was separated and not recovered. Two of the blade bores contained sections of a blade root (Figure 2). The blade positions were arbitrarily numbered '1-3' for tracking purposes, where the position with the retained blade was labeled '1', the position containing the root that matched to the separated blade (based on fracture surface geometries) was '2', and the position containing the root of the missing blade was '3'. The blades had separated from the polymer cap at

the butt end of the propeller, leaving behind portions of wood attached to the walls of the cap and below the securing bolt.

Both propeller blades were stamped with "B745" on the forward face and "68 G6" on the aft. Per the manufacturer's website, these numbers were reference balance numbers, and all blades in a set should have the same numbers.¹ The manufacturer stated that the "G6" marking indicated that the blade was manufactured in June of 2006. A GSC Systems service bulletin dated May 17, 1999 stated that the propellers should be overhauled every 500 hours or 5 years.²

The spacing between the two halves of the hub was checked by fitting shims of known thickness into the gap between the upper and lower half. The spacing ranged between 0.016 and 0.022 inch. Figure 3 shows a schematic of the spacing measurements. The tightening torques of the two bolts in the lug around blade 1 were measured with a torque transducer. The transducer was attached to the bolt head, and increasing clockwise torque was applied until the bolts started to turn. The tightening torque on the bolt near the leading edge of the propeller blade was measured at 32.4 in-lbs. Recorded data was not captured for the trailing bolt; however, qualitative observation of the transducer's display during testing showed a similar tightening torque. Instructions from the manufacturer call for a tightening torque between 75 and 100 in-lbs, leaving a gap of 0.030 inches between the two halves of the hub.^{3, 4} The previously-cited service bulletin warned that overtightening of the hub bolts could lead to "premature blade failure resulting in injury or death."

Disassembly of the hub revealed that the blade installed at position 1 had started to separate near the inboard corner of a circumferential groove in the root (Figure 4). The gap between the two pieces of the root (where wood was visible) was approximately 0.105 inch at the leading edge and 0.150 inch at the trailing edge. The separation was also visible in the attachment bolt through-hole. The other two blade roots showed separation at similar locations. Blade 1 was wedged into one half of the hub; a rubber mallet was used to remove the blade from the hub. Rubbing wear was observed on all root surfaces that had been in contact with the metal hub. Black material was also visible on the inside surface of the blade retention lugs where they had been in contact with the blade roots, especially near the split line of the hub (Figure 5).

¹ "What do these numbers mean, which are stamped on my blades?" retrieved from <https://www.gsc-systems.com/ppg-propellers-technical-information/> on 06/05/2025.

² "May 17, 1999 - GSC Systems Service Bulletin," retrieved from <https://www.gsc-systems.com/ppg-propellers-technical-information/> on 06/05/2025

³ "Assembly instructions for tech series propellers", GSC Systems Ltd, retrieved from <https://www.gsc-systems.com/> on 04/08/2025

⁴ "Should there be a gap between my hub halves?" retrieved from <https://www.gsc-systems.com/ppg-propellers-technical-information/> on 04/08/2025

Blade 1 was cross-sectioned in the separation region to view the fracture surface on the cap. The blade roots were rinsed in water and subjected to examination using optical microscopy. Inspection of the fracture surfaces on the polymer cap from all three blades revealed features consistent with progressive cracking. Thumbnail cracks were visible at the 4:00 and 5:00 positions on the cap from blade 1, each approximately 0.25 inch wide and 0.03 inch deep (Figure 6).⁵ Similar features were intermittently visible extending around the aft portion of the blade towards the 7:00 position. The cap on the blade 2 root showed a thumbnail-shaped crack with progressive beach marks extending from the outside edge of the sleeve at approximately the 4:00 position (Figure 7). The crack was approximately 0.5 inch across and extended approximately 0.02 inch at a 45° angle inboard from the plane of the adjacent groove face. The cap on the blade 3 root showed a series of adjacent thumbnail cracks approximately centered around the 6:30 position (Figure 8). In total, the cracks covered a 1-inch arc of the fracture surface, and the deepest point was approximately 0.03 inch.

The plastic caps on all three blade roots showed an impression left by the split line of the hub. This impression was visible in the groove surfaces and extended down the lead and trailing sides of the cap. The widths of the impressions on each cap were measured using Keyence VHX-7000 software. Figure 9 shows an exemplar measurement of an impression. Table 1 contains the average impression width measured on the trailing and leading edge of each cap. The metal edge of the hub in the corresponding locations (that would have been in contact with these areas of the caps) showed little or inconsistent bevel, with some showing no bevel.

Table 1. Average width of the impression in the caps at the root of the propeller blade (average of 4 measurements), in inches.

Root Number	Trailing Edge	Leading Edge
1	0.027±0.001	0.024±0.001
2*	0.027±0.001	0.028±0.001
3*	0.026±0.002	0.026±0.002

* Impressions on roots 2 and 3 did not have clearly defined edges. The measurements here represent an approximate maximum based on visual examination.

Examination of the fractured wood surfaces from the hubs showed shearing damage mostly parallel to the wood grain. No evidence of moisture or staining was visible on the wood fracture surfaces. The root of blade 3 showed sections of angled surface where the wood had separated at or near layers of adhesive in the root (Figure 10). The root was cross-sectioned and examined with an optical stereoscope. No separation or porosity was noted in the cross-sectioned portion of the adhesive layers (Figure 11).

⁵ Radial location defined by clock face position, where the forward direction is at 12:00, the leading edge (as determined by the propeller's rotational direction) is 3:00, and the aft direction is 6:00.

Submitted by:

Brian Fuchs, Ph.D.
Materials Engineer



Figure 1. Propeller blades and hub as received.

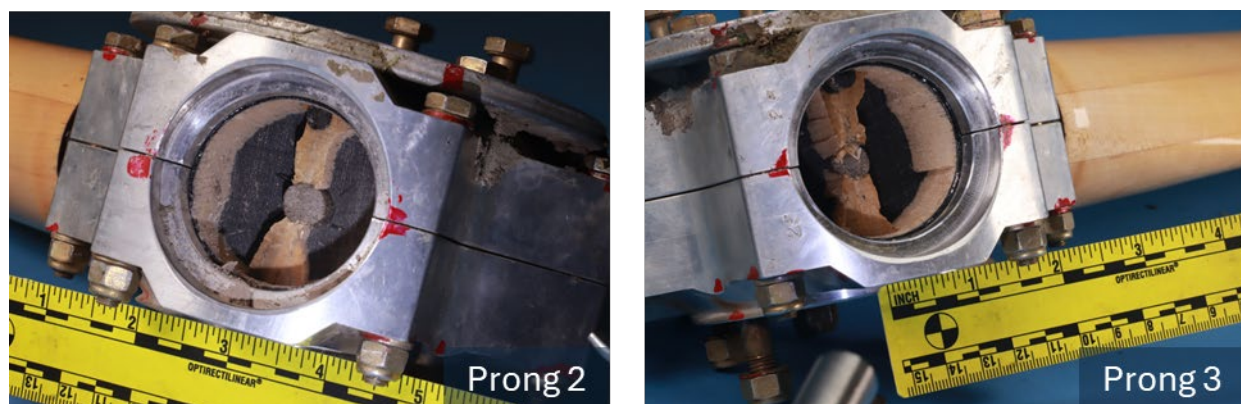


Figure 2. (Left) The blade root in lug 2. (Right) The blade root in lug 3.

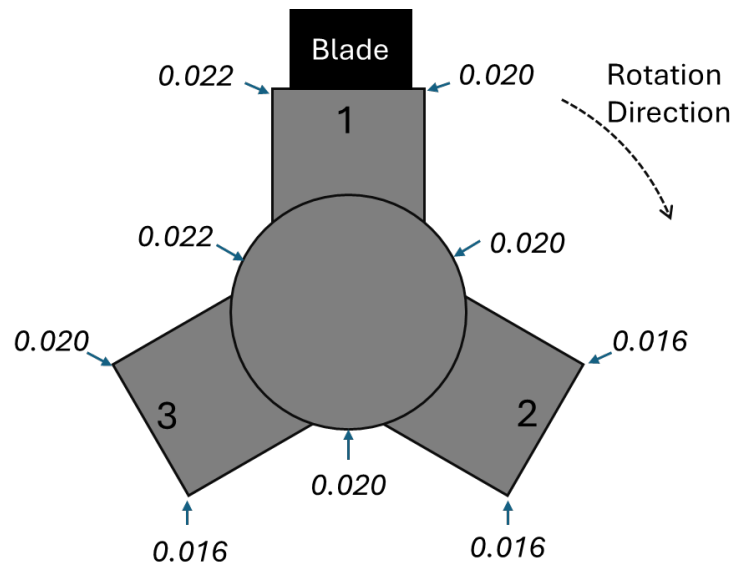


Figure 3. Schematic (not to scale) of the propeller hub viewed from the aft, looking forward. Labels in *italics* indicate the measured spacing, in inches, between the two halves of the hub.

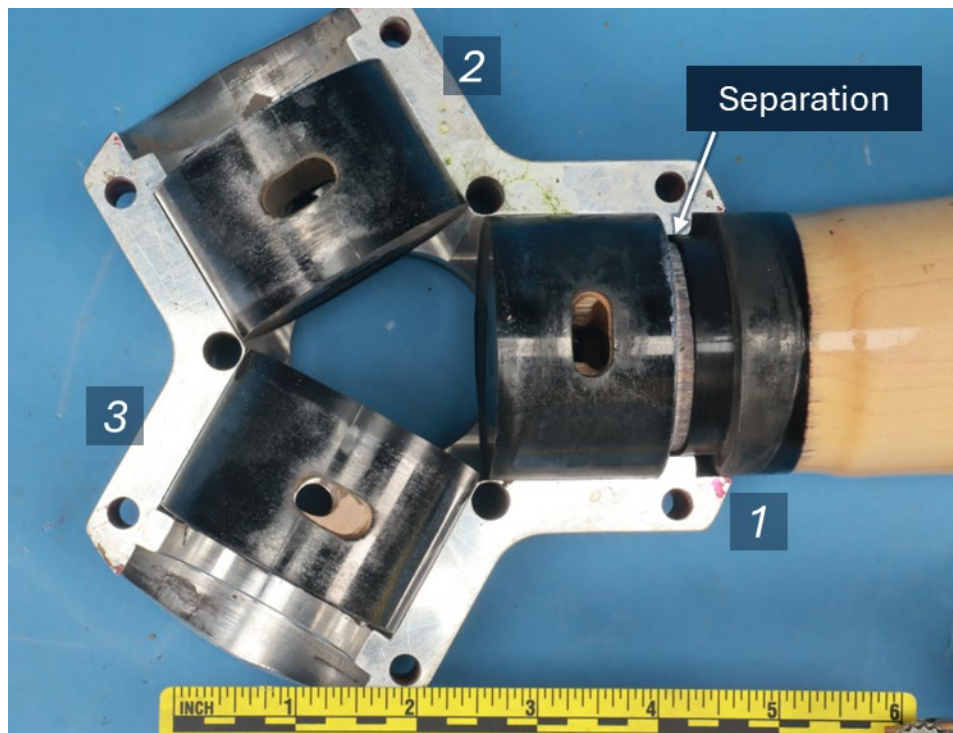


Figure 4. Propeller hub with the front half of the casing removed.

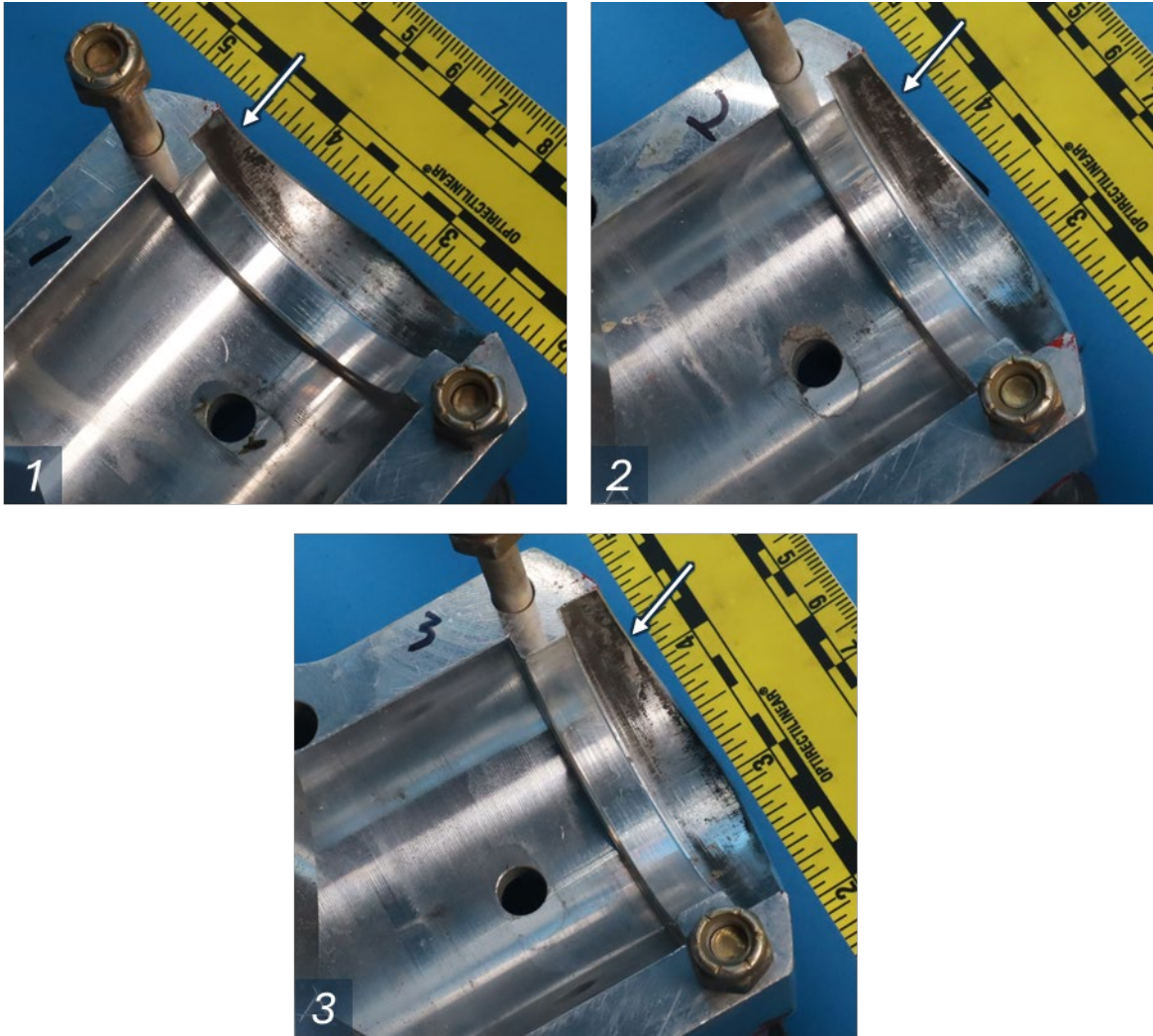


Figure 5. The three blade retaining lugs of the forward half of the hub (lug label in the lower left-hand corner of each image). The white arrows point to black residue was visible near the split line of all three lugs.

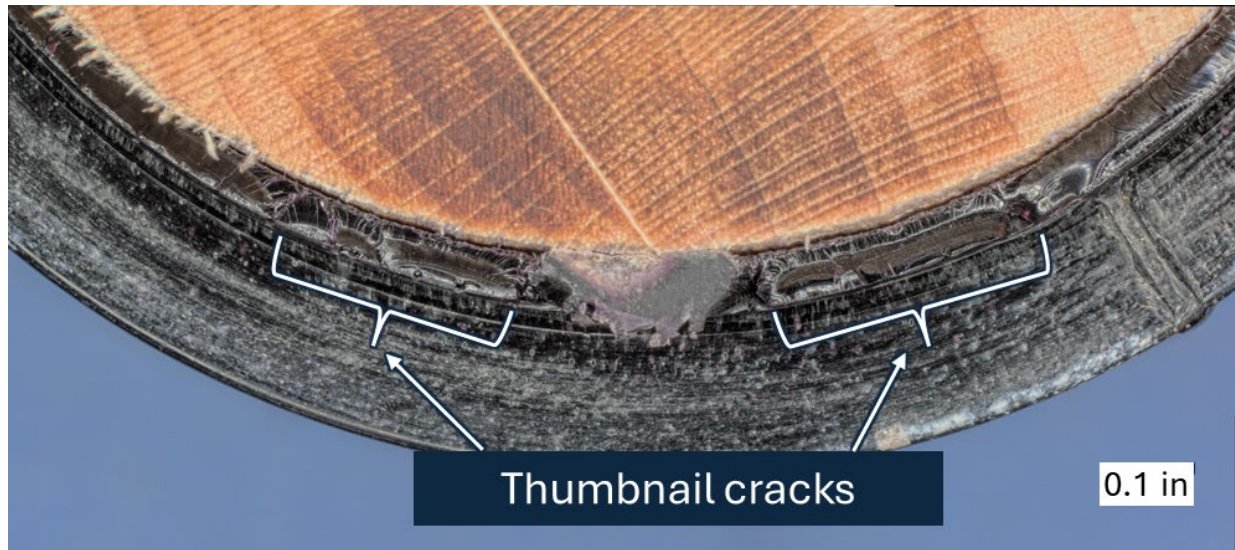


Figure 6. Thumb nail cracks in the plastic cap on the root of blade 1 near the 4:00 and 5:00 positions.

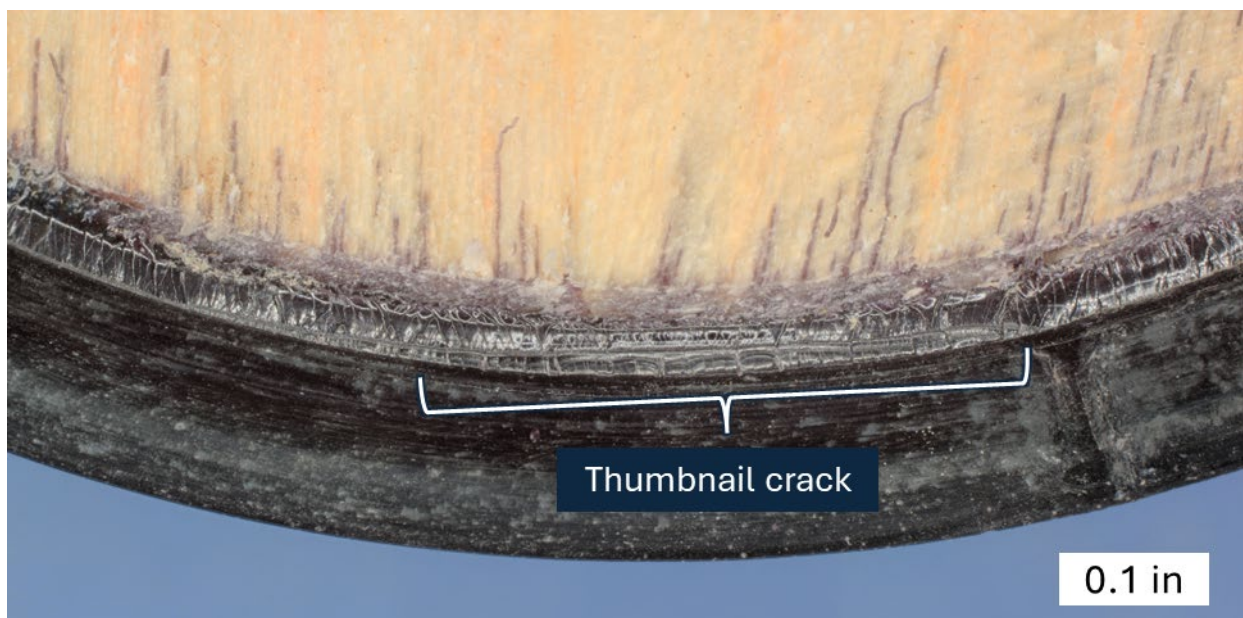


Figure 7. Thumb nail crack in the plastic cap on the root of blade 2 near the 4:00 position.

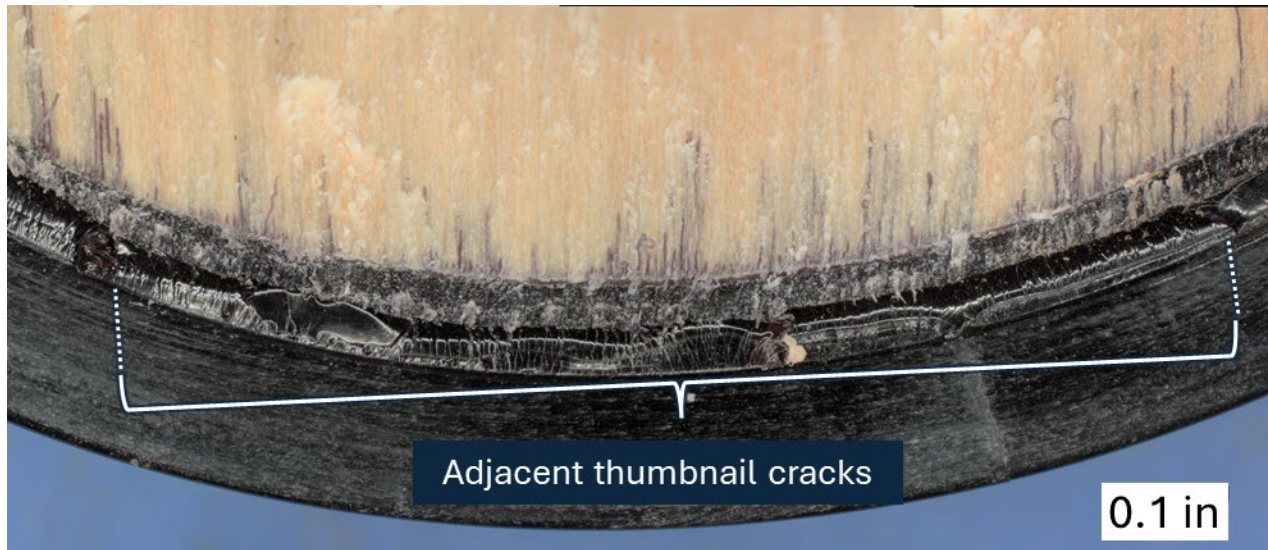


Figure 8. Thumbnail cracks in the plastic cap of the root of blade 3 near the 6:30 position.

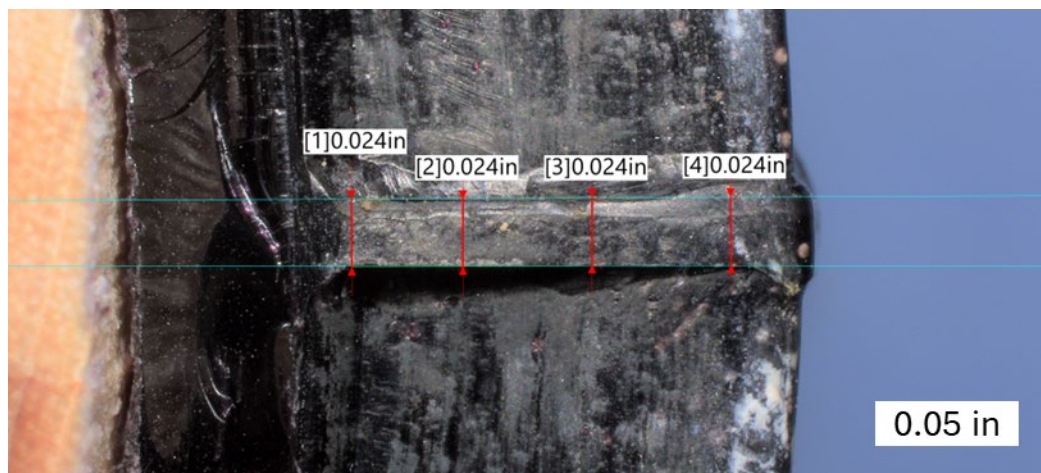


Figure 9. Exemplar measurements of the split line impression on the cap of the blade 1 root.

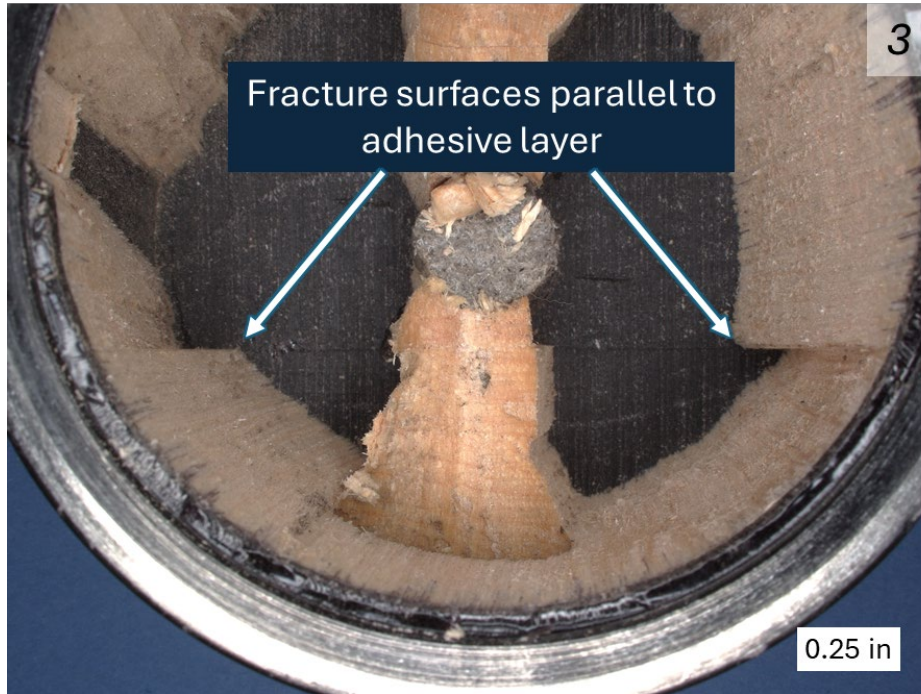


Figure 10. Angled fracture surfaces following the adhesive layer between wood laminates in the blade 3 root.

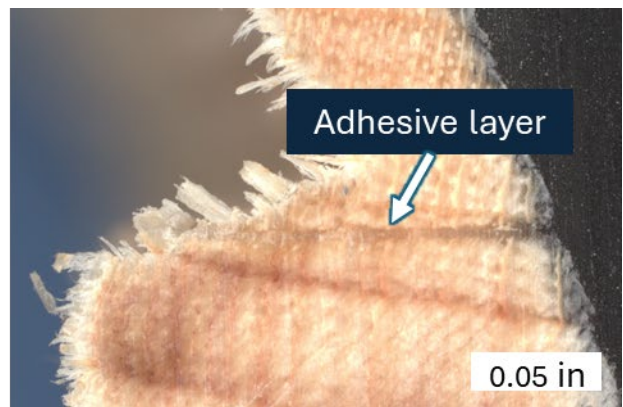
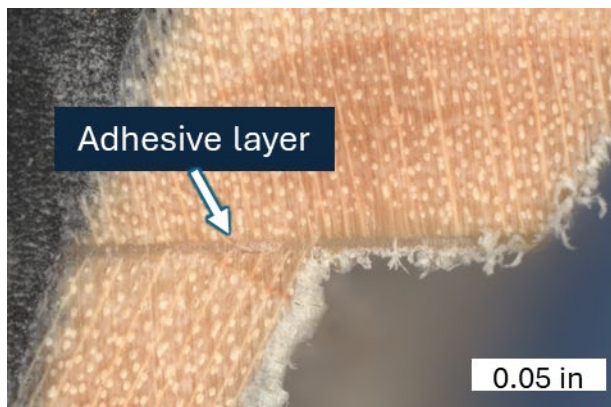


Figure 11. (Left) Cross-sectioned blade 3 root showing the fracture surface partially following the adhesive layer. (Right) The crack did not follow the adhesive layer on the opposite side of the fracture surface.