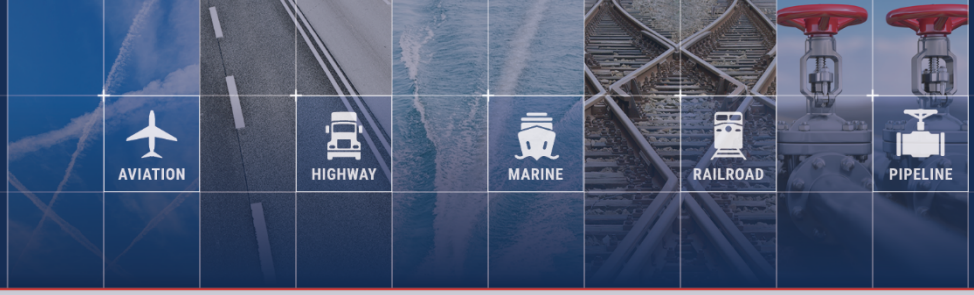


Aviation Investigation Final Report

Location:	Pine Grove, Oregon	**Accident Number:**	WPR20LA283
Date & Time:	August 24, 2020, 18:00 Local	**Registration:**	N314
Aircraft:	Kaman K 1200	**Aircraft Damage:**	Substantial
Defining Event:	Aircraft structural failure	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The pilot had been conducting fire suppression activities for the United States Forest Service using a water bucket suspended at the end of a 140-ft longline. The pilot informed the controller that he would need to return to the base for fuel after another bucket of water, which was the last communication between the controller and the pilot. The helicopter was subsequently located in a river at the dip site. No mayday call was received.

Onboard global position system (GPS) data revealed that the helicopter had arrived at the dip site and was hovering at an altitude of 138 ft above the water, which would place the helicopter about 40 ft above the treetops. The water bucket would have been near or in the water. No evidence showed any signs of rotor system contact with the trees. However, evidence did show that the helicopter rolled to the left as it descended and the 140-ft longline wrapped around the fuselage during the descent. The helicopter then struck the river in an inverted position and continued to roll to the left until it came to rest on its right side. The lack of damage to the longline demonstrated that both rotor systems and pylons had separated from the fuselage while the helicopter was in flight. The left rotor blades were found 560 ft away from the main wreckage.

Postaccident examination revealed that the damage observed on the right rotor blades, right hub, and right pylon occurred after they were struck by the left rotor blades while the helicopter was above the dip site. The damage observed on the left rotor system occurred when it hit the right rotor system while in flight. This intermeshing contact resulted in the in-flight separation and breakup of the left rotor blades.

The failure of the left white blade servo flap started as a fracture of the lower skin at the spar-to-afterbody transition and peel separation of the upper skin before transitioning to fracture of

both upper and lower skins at the transition. The transition between separation modes, onset of reverse bending damage at the outboard closeout, and the extent of damage to the left white blade servo flap compared to the servo flaps from the remaining three blades indicates that the left white blade servo flap was cracked at its inboard end prior to the collision between the left and right rotor systems. The inboard end crack grew progressively and compromised the structural integrity of the servo flap leading to the failure and eventual separation of the afterbody.

Failure of the left white blade servo flap resulted in a loss of control of the left white blade. However, it could not be determined why the left white blade servo flap failure ultimately resulted in a collision between the left and right rotor systems in this accident. A past event involving a servo flap separation demonstrated that the loss of a servo flap does not always result in catastrophic consequences. It is likely that flight control inputs, including the pilot's responses to an abnormal vibration in the rotor system, were a factor to the catastrophic outcome of the servo flap failure in this accident. The lack of flight data precluded analysis of the control inputs leading up to the collision between the left and right rotor systems.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

An in-flight breakup resulting from contact of the left rotor system with the right rotor system after an in-flight failure of a servo flap from a left rotor blade.

Findings

Aircraft	Main rotor blade system - Failure

Factual Information

History of Flight

Approach	Aircraft structural failure (Defining event)

On August 24, 2020, about 1747 Pacific daylight time, a Kaman K-1200 helicopter, N314, was substantially damaged when it was involved in an accident near Pine Grove, Oregon. The pilot was fatally injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 133 external load flight.

The helicopter was operated under an exclusive-use contract with the United States Forest Service (USFS) and had been conducting water bucket/fire suppression activities for the White River fire at Mt. Hood National Forest, Oregon. The air attack controller, who was in radio contact with the pilot, reported that the pilot indicated that he needed to return to the heliport to refuel after “one more bucket.” The pilot provided no further transmissions to the air attack controller. About 15 minutes later, the air attack controller contacted dispatch and learned that the helicopter had not returned to the heliport. The air attack controller then flew to the dip site, where he observed the helicopter lying on its right side in the river at the dip site. No “mayday” radio call was received from the accident pilot.

Onboard GPS instrumentation revealed that, about 1745 on the day of the accident, the helicopter was about 0.75 miles southwest of the accident dip site. The helicopter returned to the dip site and began to slow down and descend over the dip site. The last recorded data point was about 138 ft above ground level at 0 knots and was about 15 ft from the location of the main wreckage; see figure 1.

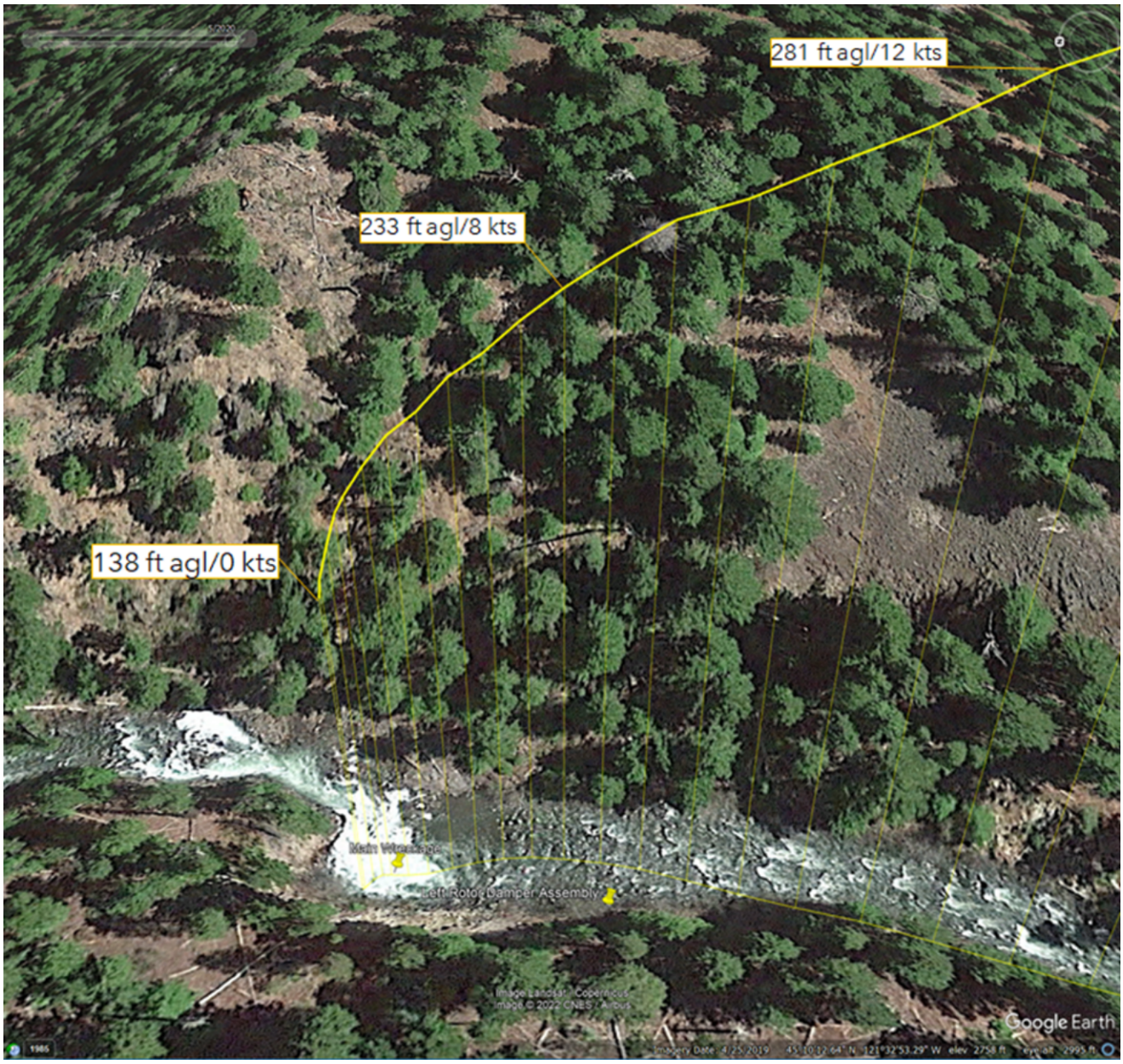

281 ft agl/12 kts
233 ft agl/8 kts
138 ft agl/0 kts
Main Wreckage
Left Rotor Damper Assembly
Image Landsat / Copernicus
Image © 2022 CNES / Airbus
Google Earth

Figure 1. Flightpath showing the helicopter's height above ground level and speed.

Note: The spacing between each vertical line represents a 1-second interval.

Pilot Information

Certificate:	Commercial	**Age:**	40,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Single
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	5-point
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	May 20, 2020
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	July 16, 2020
Flight Time:	(Estimated) 4425 hours (Total, all aircraft), 2086 hours (Total, this make and model)		

According to a family member, the pilot had about 10 years of flight experience in the helicopter make and model, and he performed the "more difficult operations" for the operator.

Aircraft and Owner/Operator Information

Aircraft Make:	Kaman	**Registration:**	N314
Model/Series:	K 1200 No Series	**Aircraft Category:**	Helicopter
Year of Manufacture:	2001	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	A94-0032
Landing Gear Type:	Tricycle	**Seats:**	1
Date/Type of Last Inspection:	February 25, 2020 100 hour	**Certified Max Gross Wt.:**	12000 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:	5287 Hrs at time of accident	**Engine Manufacturer:**	Honeywell
ELT:	C126 installed, not activated	**Engine Model/Series:**	T5317A-1
Registered Owner:	Central Copters Inc	**Rated Power:**	1350 Horsepower
Operator:	Central Copters Inc	**Operating Certificate(s) Held:**	Rotorcraft external load (133), On-demand air taxi (135), Agricultural aircraft (137)

The K-1200 helicopter had two counterrotating, side-by-side, intermeshing rotors with two blades per rotor (for a total of four blades). The rotors were out of phase by 90° and were tilted outward to allow each blade to clear its opposing rotor hub. The two rotor systems were mounted to, and driven by, a common transmission. When viewed from above, the left rotor system turned counterclockwise, and the right rotor system turned clockwise. The two blades for each rotor system comprised a matched set that was balanced at the helicopter manufacturer's factory; each set had an "A" blade (colored white at the tip) and a "B" blade (colored red at the tip). Figure 2 shows the accident helicopter. The helicopter was not equipped with, or required to be equipped with, a flight data recorder.

Figure 2. Accident helicopter (Source: Central Copters).

The K-1200 rotor system used servo-flaps to control rotor blade pitch changes. The *Kaman K-1200 Maintenance and Servicing Instructions* document states the following about servo flaps:

> *A servo-flap is mounted on each blade near the 3/4 radius and is controlled by [control] rods which transfer conventional cockpit flight control inputs through the azimuth assemblies to each servo flap. The servo-flap controls the pitch of the rotor blade and acts as an aerodynamic stabilizer. Because the servo-flap uses energy drawn from the air stream to twist the blade, control forces need only be high enough to deflect the small servo-flap.*

The accident helicopter was maintained under the manufacturer's approved airworthiness inspection program. Recurring inspections for the rotor blade servo flaps in the K-12 maintenance manual included the preflight inspection and the 100 hour/annual or zone one progressive inspection. A review of the maintenance logbooks revealed that the last zone one inspection occurred on February 25, 2020.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KDLS,234 ft msl	**Distance from Accident Site:**	31 Nautical Miles
Observation Time:	23:53 Local	**Direction from Accident Site:**	31°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	18 knots / 24 knots	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	290°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.8 inches Hg	**Temperature/Dew Point:**	31°C / 4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Hood River, OR (4S2)	**Type of Flight Plan Filed:**	VFR
Destination:	Hood River, OR (4S2)	**Type of Clearance:**	None
Departure Time:	11:30 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	45.170326,-121.54867(est)

The dip site, where the helicopter came to rest, was lined on three sides by trees with a height of about 100 ft. No evidence indicated an in-flight impact with any of the trees surrounding the accident site.

The entire airframe was found at the accident site, and no evidence indicated an in-flight fuselage breakup. The nose of the helicopter had crushed aft and inward, which was

consistent with contacting the river in an inverted attitude. The tailboom exhibited deformation on its underside immediately aft of the horizontal stabilizer, resulting in downward bending of the aft portion of the tailboom. The left horizontal stabilizer remained installed. The right horizontal stabilizer had fractured and separated but was found next to its normally installed location. The main and nose landing gears remained attached to the fuselage. The vertical fin remained attached to the tailboom, but its top end was impact damaged.

The 140-ft-long line, which remained attached to the cargo hook of the helicopter, had wrapped around the fuselage in a direction consistent with the fuselage rolling to the left around the long line (or, conversely, the long line wrapping above and to the right of the fuselage). The water bucket remained attached to the end of the long line and was found about 40 ft upstream of the accident site. The long line was not damaged, and the water bucket sustained minor damage.

The engine and transmission remained attached in the helicopter. Both left and right transmission pylons had separated from the main transmission center housing and were found adjacent to the main transmission. Examination of the engine revealed no evidence of mechanical malfunctions or failures that would have precluded normal operation.

Examination of the rotor blades found damage that included (but was not limited to) root end fractures on the left main rotors and contact marks on the left and right rotors. All blade dampers separated from their respective rotor systems; one was recovered. Both the left and right blade sets exhibited damage consistent with the blades leading and lagging beyond the stops.

Flight control continuity was established for the cyclic, collective, and pedal controls. The control tubes and bellcranks from the cockpit controls to the azimuth control installation exhibited impact fractures but no evidence of disconnection. The left and right azimuth controls remained attached to the lower side of the main transmission.

Left Rotor System

The white rotor blade fractured into three sections and separated from the hub near the root ends. The largest section of the white blade was found in a wooded area about 560 ft from the main wreckage. The tip section was located near the largest blade section and exhibited significant deformation in multiple locations. The inboard section of the white blade remained attached to its rotor head grip.

The white blade’s servo flap spar remained attached to the blade, but the servo-flap afterbody had completely fractured and separated from the spar and was found about 192 ft from the main wreckage. Both the upper and lower fractures of the servo-flap afterbody were nearly straight in the spanwise direction.

The red blade fractured into two locations. Most of the red blade was found in a wooded area about 500 ft from the main wreckage. The tip section was found in the wooded area about 570

ft from the main wreckage. The underside of the blade exhibited a dark-colored triangular-shaped rub mark, similar in color to the leading-edge coating of the rotor blades, as well as impact marks on the spar, core, and skin, consistent with a scuff and blunt impact marks along the leading edge of the right white blade. The inboard section of the left red blade remained attached to its rotor head grip. The red blade servo flap was whole and remained attached to the blade.

Right Rotor System

The right white blade remained attached to the rotor head but fractured and partially separated in four locations. Most of the right white blade was found adjacent to the main wreckage. The right white servo flap was whole and remained attached to the blade.

The right red rotor blade fractured in one location, with most of the blade found about 81 ft from the main wreckage. The inboard section remained attached to its rotor head grip.

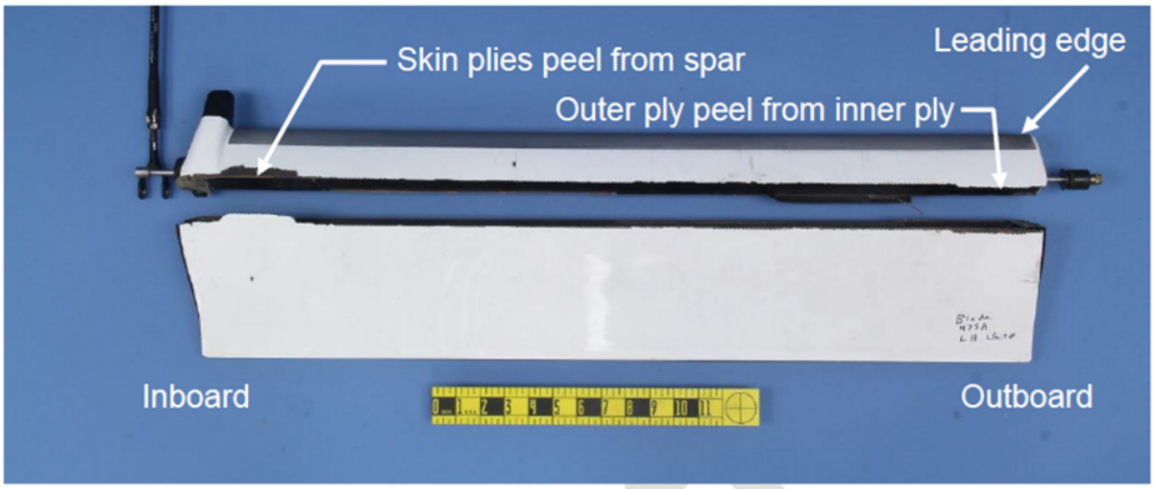
The right red servo flap was whole and remained attached to the blade. Damage was observed at the outboard end of the right red servo flap. The outboard closeout had cracked along the upper and lower bond lines. The cracks started near the mid-afterbody I-beam and extended forward and aft. The lower afterbody skin was cracked in the spanwise direction at the outboard end. One crack coincided with the trailing side of the spar, and the other crack coincided with the forward end of the trailing edge.

Servo Flap Examination

The four servo flaps were further examined at the National Transportation Safety Board (NTSB) Materials Laboratory.

The separation of the left white servo flap afterbody occurred generally at the spar-to-afterbody transition along the spanwise direction with some regions of peel separation, as shown in figure 3. The separation started in the lower skin at the inboard end of the flap at the spar-to-afterbody transition. The fracture progressed outboard staying at or near the transition and the channel ply exhibited peel separation from the spar along the entire spanwise length. Electron microscope examination of the ply fibers revealed fiber contact damage, tensile fractures, and buckle fractures, consistent with alternating stresses. Along the upper surface, the separation also started at the inboard end of the flap and progressed outboard. The skin plies initially peeled from the spar, before transitioning to fracturing at or near the spar-to-afterbody transition, similar to the lower skin. Electron microscope examination of upper skin ply fibers in this region showed similar features as those observed for the lower skin. The channel ply also exhibited peel separation from the upper edge of the spar up to approximately 23 inches from the inboard end.

a.



b.

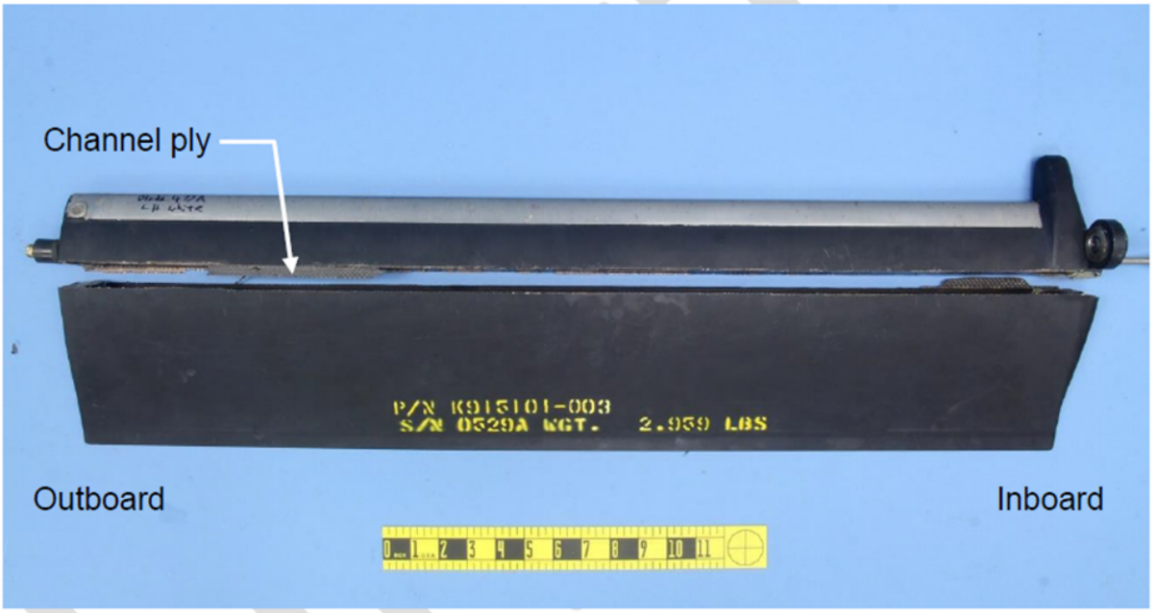


Figure 3. Separated servo-flap assembly from the left rotor/white main rotor blade showing the flap upper side (labeled a) and the flap lower side (labeled b).

The left white servo-flap closeouts were located at the inboard and outboard ends of the afterbody (see figure 4).

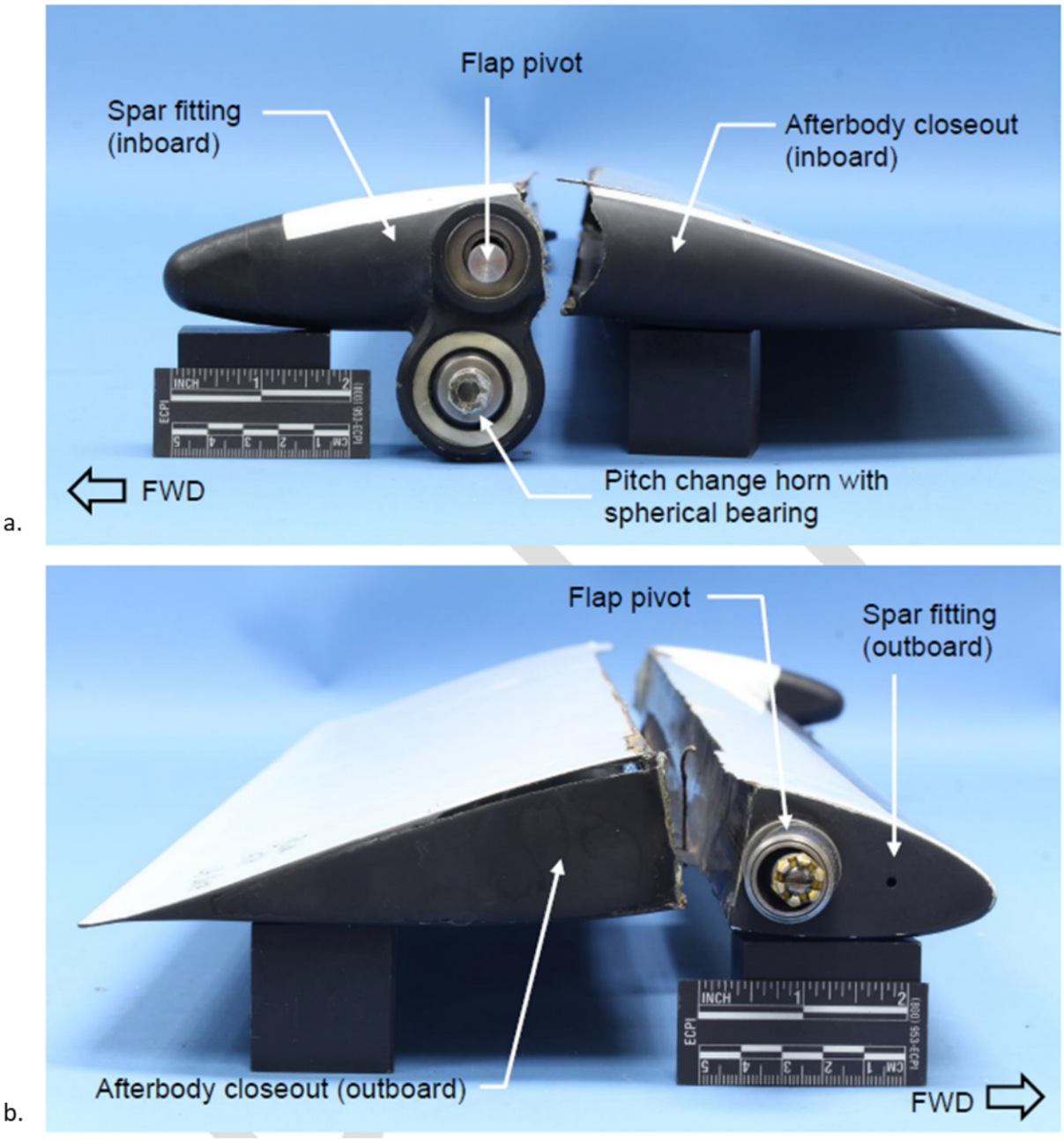
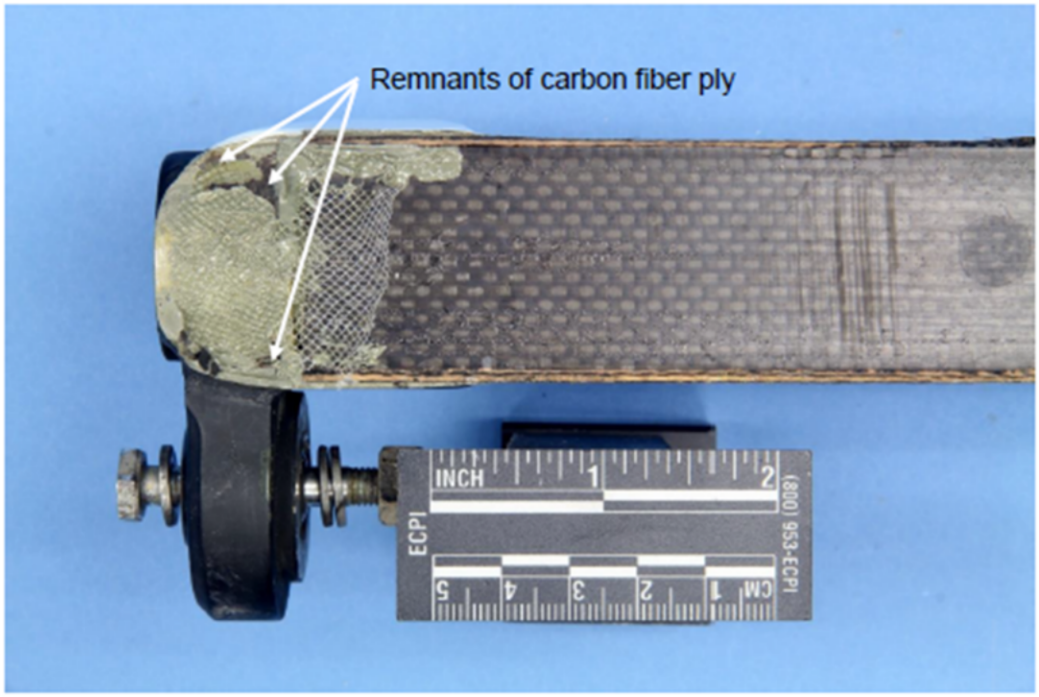


Figure 4. Separated servo flap as viewed from the inboard end looking outboard (labeled a) and the outboard end looking inboard (labeled b).

Both inboard and outboard closeouts exhibited bonding tab separation. The inboard closeout tab, which bonds the closeout to the inboard aluminum fitting, was missing (see figure 5). A green epoxy adhesive and a piece of scrim cloth had been used to bond the closeout tab to the aluminum fitting. Much of the area appeared to be unbonded. In some areas, the surface exhibited a dark brown color with a plain weave surface texture that was consistent with a remnant layer from the bonding tab.

a.



b.

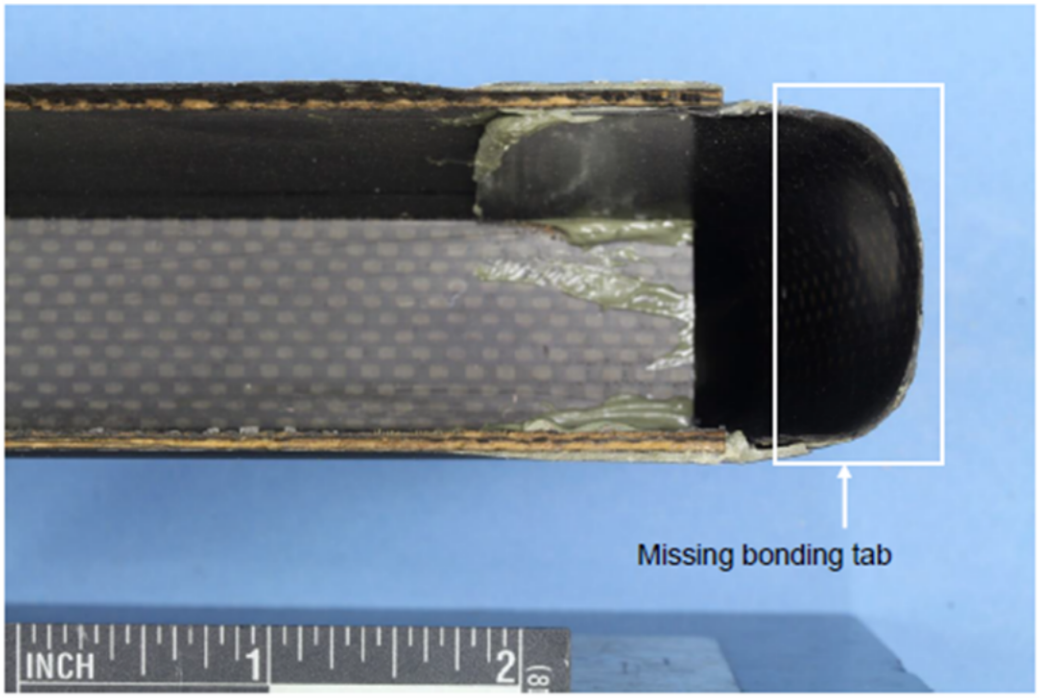


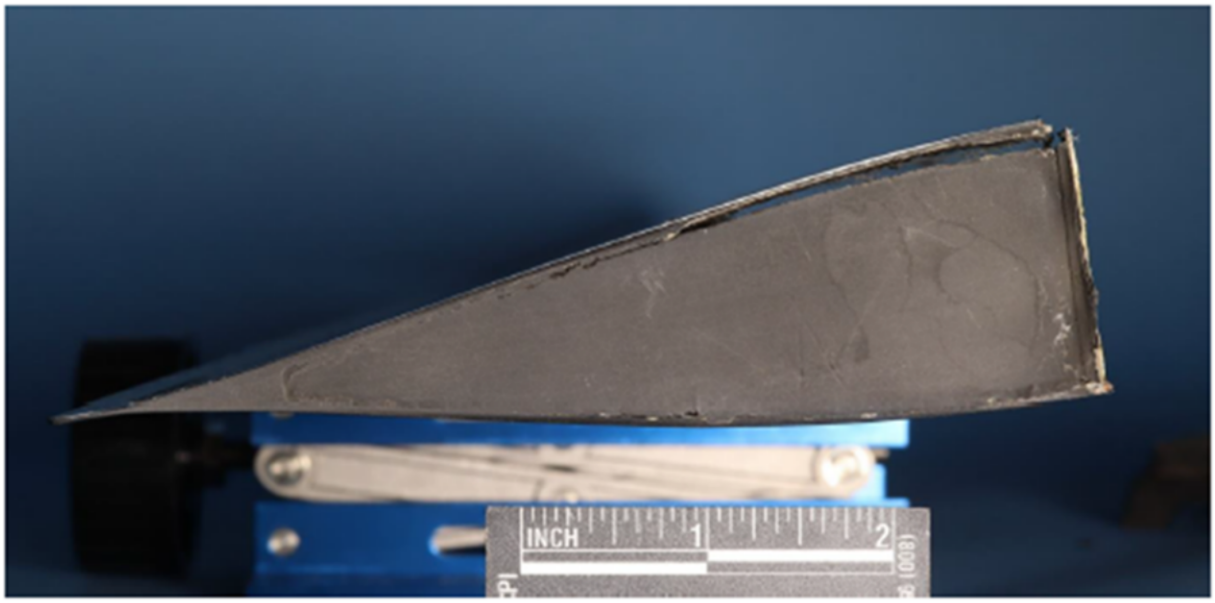
Figure 5. Inboard closeout separation spar side (labeled a) and afterbody side (labeled b).

Crack propagation features in the fractured adhesive were used to trace the fracture path from around the perimeter to an origin at the lower inboard location of the bonding region. Along the lower edge of the bonding region, lines radiated downward and outboard. Along the inboard edge, lines and crack arrest marks were consistent with a crack progressing from the lower

side toward the upper side of the fitting. The features traced back to an origin area at the lower inboard region of the perimeter.

The outboard closeout was cracked along the upper lower edges of the bond line with the afterbody, as shown in figures 6 and 7. The crack along the lower edge started near a mid-body I-beam stiffener and progressed forward and aft about 1 inch, arresting before reaching the spar or trailing edge. Along the upper edge, a crack also extended forward and aft of the I-beam, and a closeout tab that was bonded to the forward portion of the upper afterbody skin was missing. The tab had peeled from the skin, and adhesive and carbon-fiber ply imprints were left behind. Examination of the delamination surface indicated that the tab delamination proceeded inboard and toward the leading edge. The damage to the outboard end of the flap was consistent with the onset of high-amplitude reverse bending loads.

a.



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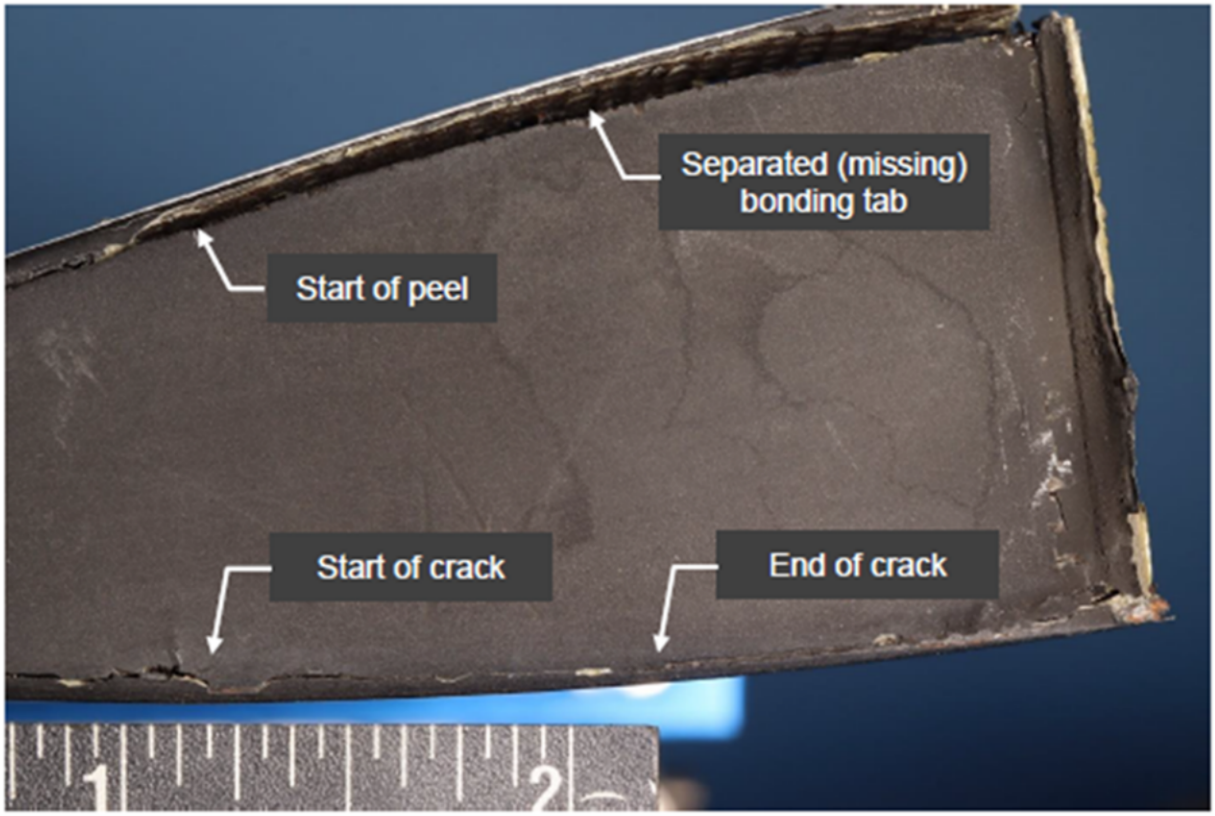
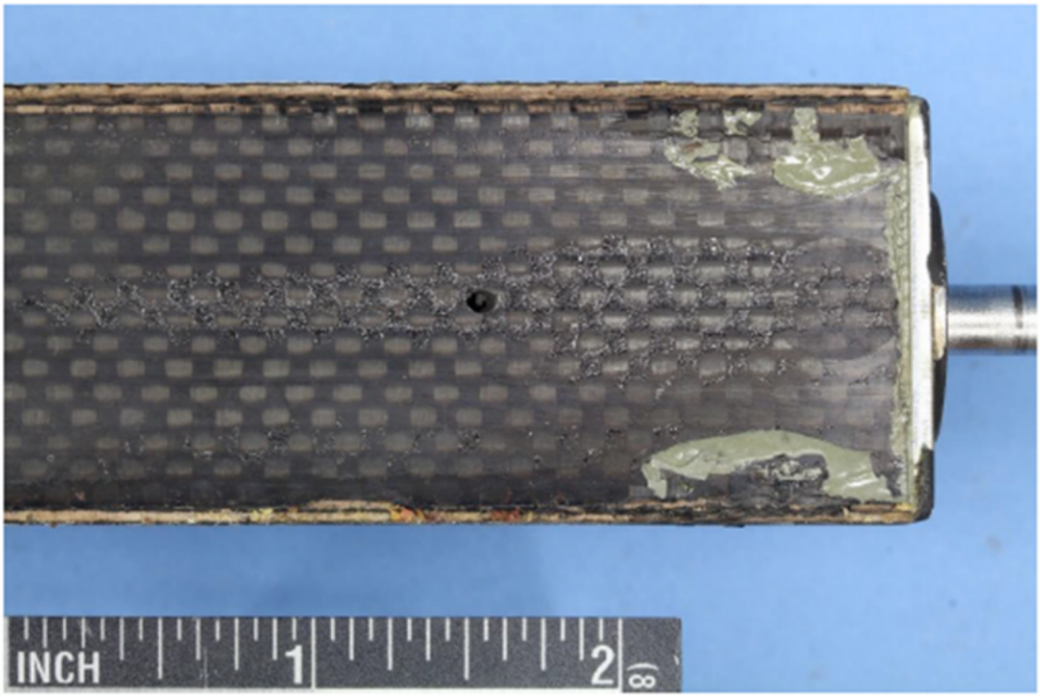


Figure 6. Outboard closeout overview (labeled a)and end of crack along lower edge and peel region of bonding tab along upper edge (labeled b).

a.



b.

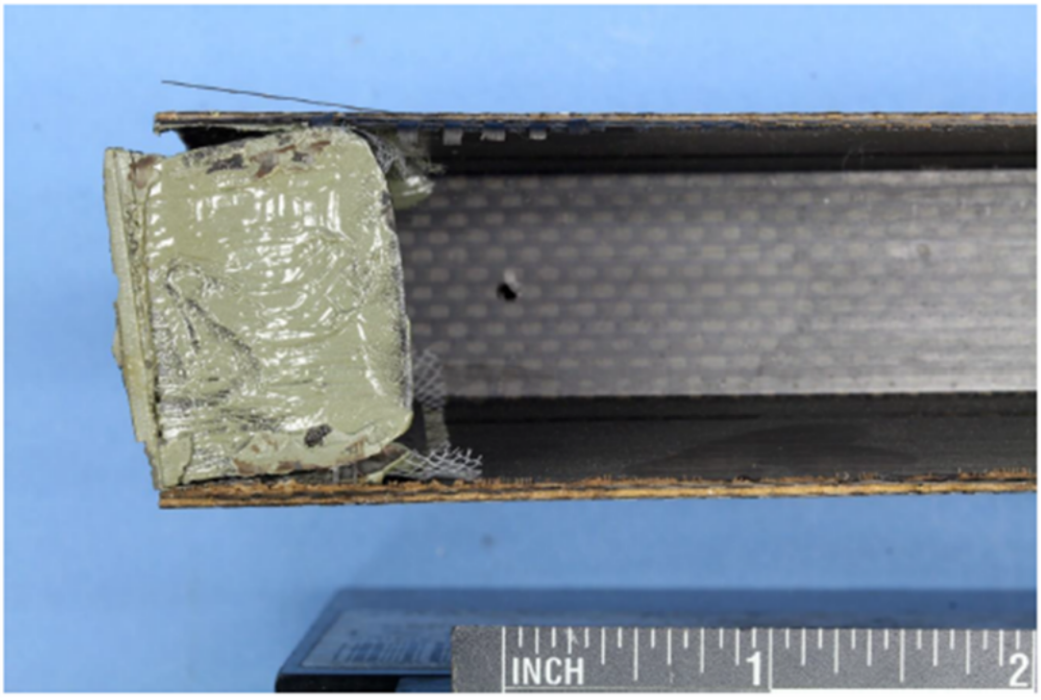
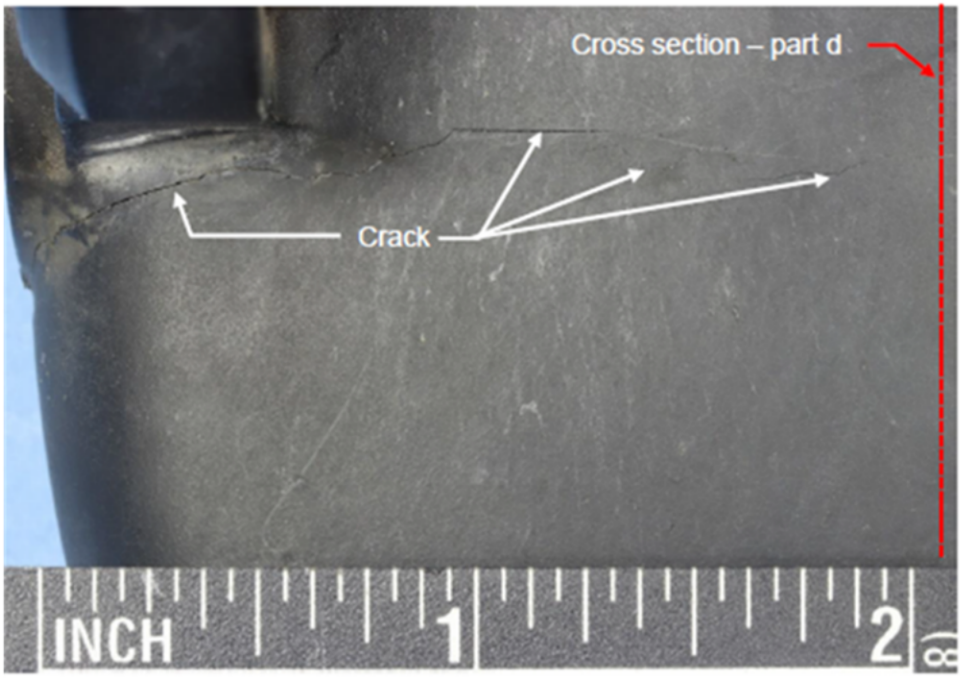


Figure 7. Outboard closeout bonding tab separation on the spar side (labeled a) and afterbody side (labeled b).

The remaining three servo flaps from the accident helicopter were examined visually for signs of cracks, particularly around the inboard closeout, and the bond between the closeout and aluminum fitting was evaluated. All flaps exhibited cracking along the bond line between the closeout and the aluminum fitting, but the extent of cracking varied. The right red servo flap

was sectioned in an area that passed through a crack along the underside of the flap. The cross-section through the crack indicated that the outer and inner skin plies were fractured beneath the surface crack, as shown in figure 8.

a.



b.

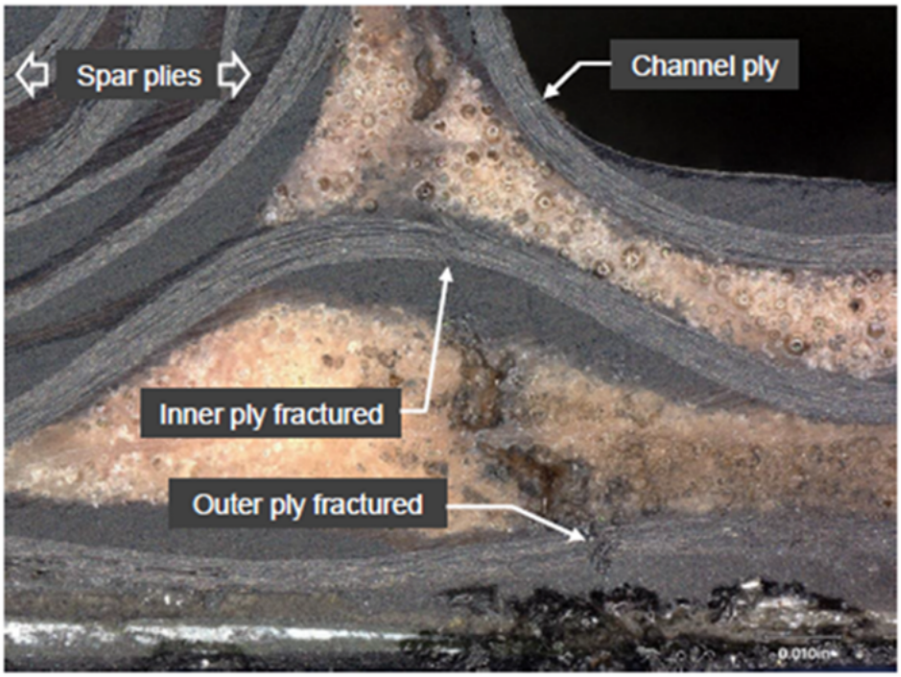


Figure 8. Lower side of closeout (labeled a) and cross-section through the lower skin plies (labeled b).

Additional Information

In April 2009, Kaman received a report that the accident helicopter (at the time registered as N361KA) experienced an inflight separation of a left white blade servo flap. The entirety of the servo flap had separated from its attachment brackets. The pilot was able to land the helicopter with no additional damage to the airframe.

On June 16, 2010, in Donnelley, Idaho, a K-1200 helicopter was involved in an accident. The investigation found the afterbody of a servo flap had completely separated. The NTSB determined the probable cause was the collision of two counter-rotating main rotor blades for undetermined reasons, which resulted in a loss of control. For more information, see case number WPR10FA295 at the NTSB's website.

The manufacturer conducted a demonstration on a whirl stand to show the effects of a rotor system with one of the two blades' servo flap having its inboard closeout removed. For this demonstration, an exemplar blade set was placed on a whirl stand and the inboard closeout was removed from the red blade servo flap. The blade set was operated at varying rotor speeds from 130 rpm to the maximum 270 rpm. Power was applied up to a maximum torque of 150%. According to the manufacturer, the demonstration yielded no signs of flutter or out-of-track conditions, and the flight control loads were not out of any limits. The blades (servo flaps) showed no signs of cracking in the bond lines, especially around the flap horn.

Administrative Information

Investigator In Charge (IIC):	Salazar, Fabian
Additional Participating Persons:	Brian Geary; Central Copters; Belgrade, MT Brad Smelser; Kaman Helicopters Dana Metz; Honeywell Aerospace; Phoenix, AZ
Original Publish Date:	April 26, 2023
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=101856