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AVIATION
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Aluminum Propeller Blades: Prevent Fractures with Proper Inspections and Maintenance

The problem

- Aluminum propeller blades can be susceptible to fatigue cracking and fracture if a small nick, pit, or corrosion on the surface or edge is not found and repaired during preflight inspection or maintenance. Such damage can concentrate stress from normal airplane operation loads, resulting in fatigue crack initiation and growth followed by propeller blade fracture. Aluminum is more commonly used for airplane propeller blades than composite propeller blades or wood.
- Fatigue cracking and fracture of a propeller blade can lead to airframe and engine damage and a possible loss of control.
- Airplanes that are used for aerial application and coastal operations may be at higher risk for propeller blade damage because they can be exposed to chemicals or salt-laden moisture, which can cause corrosion that leads to a propeller blade fracture from fatigue cracking.

Figure 1. Nick in aluminum propeller blade. (Source: Hartzell Propellers)

- Any airplane operating on an unimproved or backcountry airstrip is also at high risk for propeller blade damage because loose rocks, gravel, or debris on unimproved airstrips can create small nicks on aluminum propeller blades that can turn into large fatigue cracks.
- Not adhering to manufacturer-recommended overhaul schedules for aluminum propeller blades can lead to undetected fatigue cracks and blade separation.

Related accidents

The NTSB has investigated several accidents and incidents where a failure to properly inspect and repair small damage to aluminum propeller blades resulted in propeller blade fatigue cracking and fractures, including the following:

- The left-side Hartzell aluminum propeller blade of a Beech 58 separated from the airplane in flight; the pilot was able to land the airplane at the nearest airport. Postincident examination of the propeller blade fracture surface revealed signatures consistent with high-cycle fatigue. It is likely that damage associated with the fatigue fracture origin was present during the last 100-hour maintenance inspection, about 28 flight hours before the incident, and during the subsequent preflight inspections, though the presence of black paint covering damage in the fatigue origin area could have made it more difficult to detect. **Though obscured by paint, the defect would have been detectable with careful visual inspection, which should have prompted further inspection and repair.** (CEN22LA250)
- During the pilot's takeoff on a personal flight, a portion of the airplane's McCauley aluminum fixed pitch propeller blade separated, and the pilot performed a 180° turn to land back to the runway. Postincident examination of the propeller blade revealed fatigue cracking initiating from corrosion pits on the camber or front side, near the propeller blade tip. Maintenance records indicate that the propeller had not undergone manufacturer-recommended overhaul in the 8 years since it was

installed on the airplane in 2015. **If the recommended overhaul had been performed, the corrosion pits that led to fatigue crack initiation would likely have been detected and removed, preventing the blade separation.** (CEN23LA218)

- While a pilot was taxiing a Cessna A185 airplane for takeoff, its McCauley aluminum propeller blade fractured, leading to excessive vibrations that substantially damaged the engine mount. Postaccident examination of the fractured propeller blade revealed that a nick in the leading edge, likely from frequent operation on unpaved runways, had led to fatigue cracking and fracture. It is likely the nick was present during the preflight inspection and the pilot/operator did not adequately inspect the propeller blade. **Had the propeller blade been adequately inspected during the preflight inspections and repaired, the airplane likely would not have sustained substantial damage.** (ANC17LA052)

What can owners, operators, and pilots do?

- **During preflight inspections, inspect all areas of the propeller blade for damage such as nicks or corrosion. Include the back/face side of the blade and pay particular attention to the leading edge. Refer any findings to a qualified mechanic for inspection and repair before further flight.**
- **Following any propeller work, have a second person inspect the work. If any propeller blades need to be repaired, ask another mechanic to inspect the work if they are available or inspect the work yourself. Depending on the type of repair, another pilot may also be able to inspect the work.**
- **Consider increasing the frequency of propeller blade inspections by maintenance personnel for airplanes that are used for backcountry, aerial application, and coastal operations because they may be at higher risk for propeller blade damage.**

- **Operations that are not required to follow the manufacturer's recommended overhaul timelines, such as public aircraft, and Title 14 *Code of Federal Regulations* Part 91 and Part 137 operations, should maintain the propeller according to the manufacturer's instructions for continued airworthiness, including following manufacturer-recommended aluminum propeller blade overhaul schedules.**

What can maintenance personnel do?

- **Always properly and comprehensively inspect aluminum propeller blades:**
  - **Follow the maintenance manual and use appropriate checklists.**
  - **Inspect all areas of the propeller blade, including the back/face side of the blade, and pay particular attention to the leading edge.**
  - **Inspect the propeller blades section by section; consider marking off sections of large propellers to ensure complete coverage.**
  - **Use the best possible light and at least 10 times magnification for any questionable areas (as indicated in Advisory Circular (AC) 43.13-1B section 5-18).**
  - **Be aware of any cosmetic painting done that may obscure underlying surface damage that needs to be repaired.**
  - **Avoid distractions while performing inspections. If stepping away before completing a checklist, set a reminder about remaining items.**
  - **If any propeller blades need to be repaired, ask another mechanic to inspect the work as well. Depending on the type of repair, a pilot may also be able to inspect the work.**
  - **Add to the propeller logbook any work performed to the propeller blades.**

- **If using visible dye penetrant for inspections, ensure propeller blades are thoroughly cleaned afterward. Visible dye material residue can be extremely difficult to remove and can fill voids, flaws, and cracks, which can affect subsequent inspections.**
- **Maintain any service documents (such as service letters or service bulletins) issued on propeller blade inspections or specific blade designs.**
- **Recommend increased frequency of propeller blade inspections for airplanes that are used for backcountry, aerial application, and coastal operations because they may be at higher risk for propeller blade damage.**
- **Follow the industry best practices cited below for propeller blade inspections, as well as manufacturer-specific or specialized techniques.**
- **If a propeller is going into or coming out of long-term storage, ensure proper preservation and inspection procedures, respectively, are followed in accordance with the manufacturer's instructions.**
- **Ensure that proper propeller blade inspections are incorporated into maintenance training programs and safety management systems. Ensure that manufacturer-recommended aluminum propeller blade overhaul schedules are followed.**

Interested in more information?

- The FAA's AC 20-37E, Aircraft Propeller Maintenance, contains guidance concerning the inspection, maintenance, field repair, and periodic overhaul of all types of propeller blades.
- The FAA's AC 43.13-1B, Acceptable Methods, Techniques, and Practices – Aircraft Inspection and Repair, includes guidance concerning the inspection and repair of aluminum propeller blades when there are no manufacturer repair or maintenance instructions.

- The FAA's Advisory Aviation Maintenance Technician Handbook, volume 2, chapter 7, "Propellers," provides information on properly inspecting aluminum propeller blades.
- The FAA's Special Airworthiness Information Bulletin (SAIB) NE-08-20, Propeller Maintenance, discusses proper propeller maintenance to avoid propeller failure.
- The FAA's SAIB CE-18-26R1, Liquid Penetrant Inspection; Using Visible Dye Penetrant, discusses the hazards of failing to thoroughly clean residual dye penetrant from propeller blades after inspection.
- The FAA's SAIB NE-08-22, Propeller Search Inspection (General Visual Inspection), discusses recommended procedures for visually inspecting propellers and minor cosmetic repairs.
- The FAA Safety Team's "Avoid the Dirty Dozen" document describes 12 common causes of human factors errors during maintenance and notes that those mistakes, if not detected, would lead to accidents.