

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



August 19, 2019

MATERIALS LABORATORY FACTUAL REPORT

Report No. 19-038

A. ACCIDENT INFORMATION

Place : Aguilares, TX
Date : 7/2/2018
Vehicle : Safari Helicopter
NTSB No. : CEN18LA247
Investigator : Jennifer Rodi

B. COMPONENTS EXAMINED

Two portions of the tail rotor pinion shaft (figure 1).

C. DETAILS OF THE EXAMINATION

The tail rotor pinion shaft fractured between the portion carrying a beveled gear and that containing the helical gear (figure 1). The beveled gear had been attached to a keyed extension of the pinion shaft. Both halves of the pinion shaft fracture surface exhibited mechanical damage by recontact resulting in rubbing of the fracture surfaces (figures 2, 3). No evidence of a preexisting crack was observed during the examination of the fracture surfaces. The overall fracture macro-morphology was consistent with bending overstress. Spalling craters were observed on the flanks of some of the helical gear teeth (figure 4).

Using X-ray fluorescence spectroscopy, the pinion shaft material composition was determined to be consistent with type 8620 alloy steel.

The pinion shaft was sectioned as shown in figure 5. A metallurgical mount was prepared from a portion of that section to examine the pinion shaft and helical gear tooth microstructure. The micrographs in figures 6, 7 exhibit a martensitic microstructure consistent with carburization case hardening.

Microhardness measurements made on the section cut from the helical gear established a maximum surface hardness of the gear tooth of 59 HRC. At the pitch diameter and at a depth of approximately 0.009 inch the hardness of the gear tooth was found to be 57 HRC. At a depth of approximately 0.015 inch the hardness was 54 HRC. Microhardness measurements made at the gear tooth core recorded an average value of 31HRC. These hardness values are consistent with the specification for the pinion shaft.

Joseph Panagiotou
Fire Protection Engineer



Figure 1: Two portions of a tail rotor pinion shaft as received.

Beveled gear side

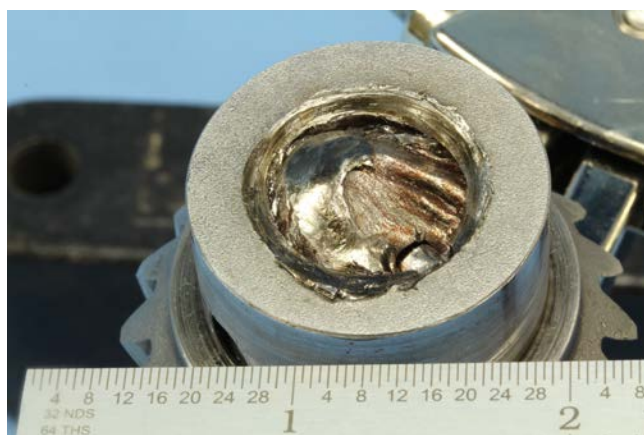


Helical gear side



Figure 2: Fracture surface on both the beveled gear side and helical gear side.

Beveled gear side



Helical gear side



Figure 3: Fracture surface on both the beveled gear side and helical gear side.

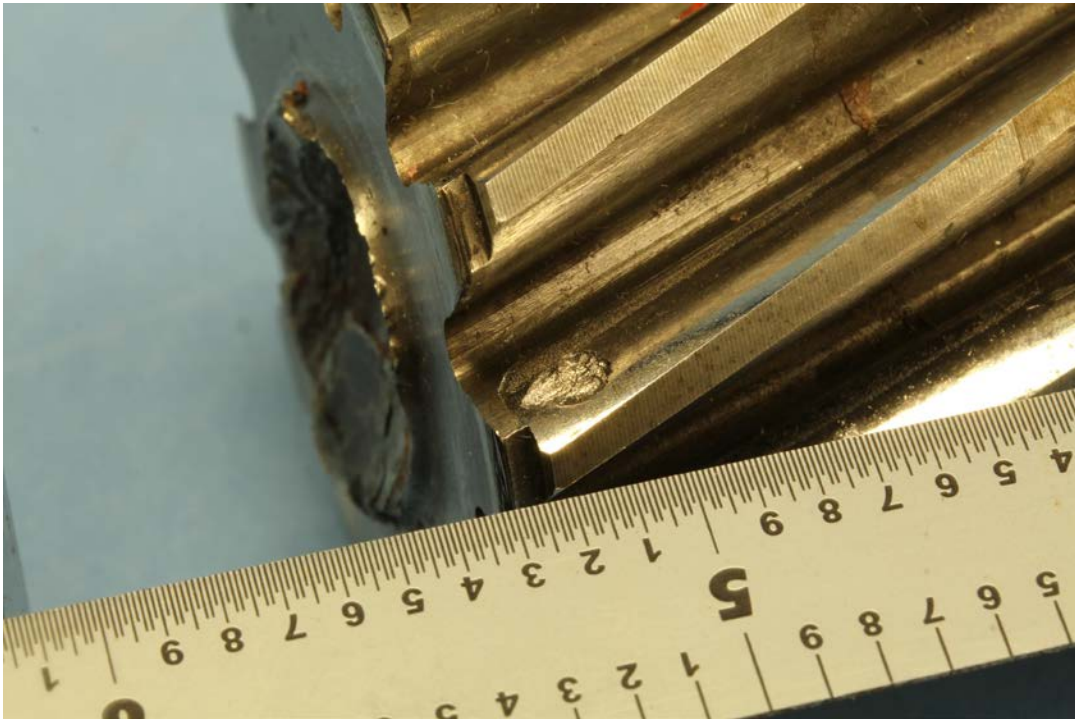


Figure 4: Spalling crater on flank of helical gear tooth.

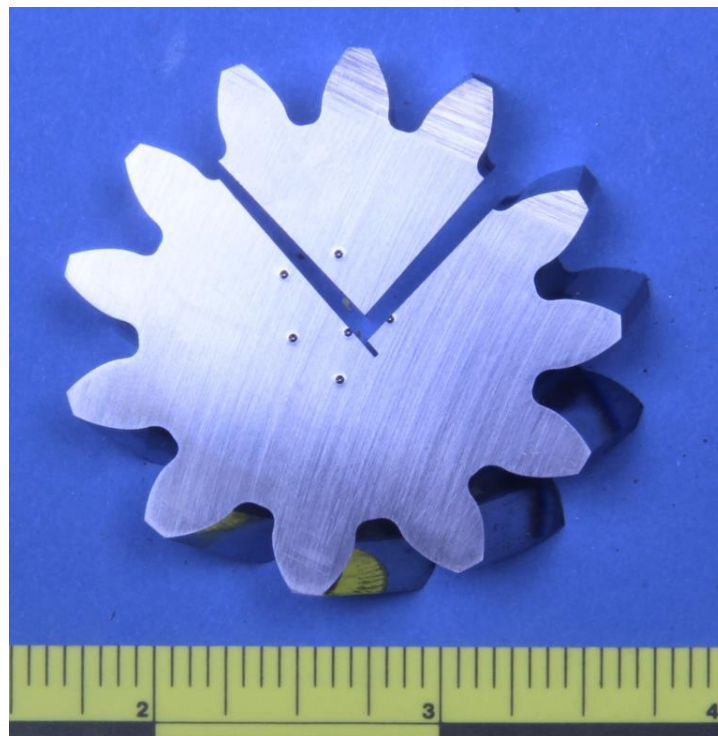


Figure 5: Section cut from helical gear portion of pinion shaft for metallographic examination.

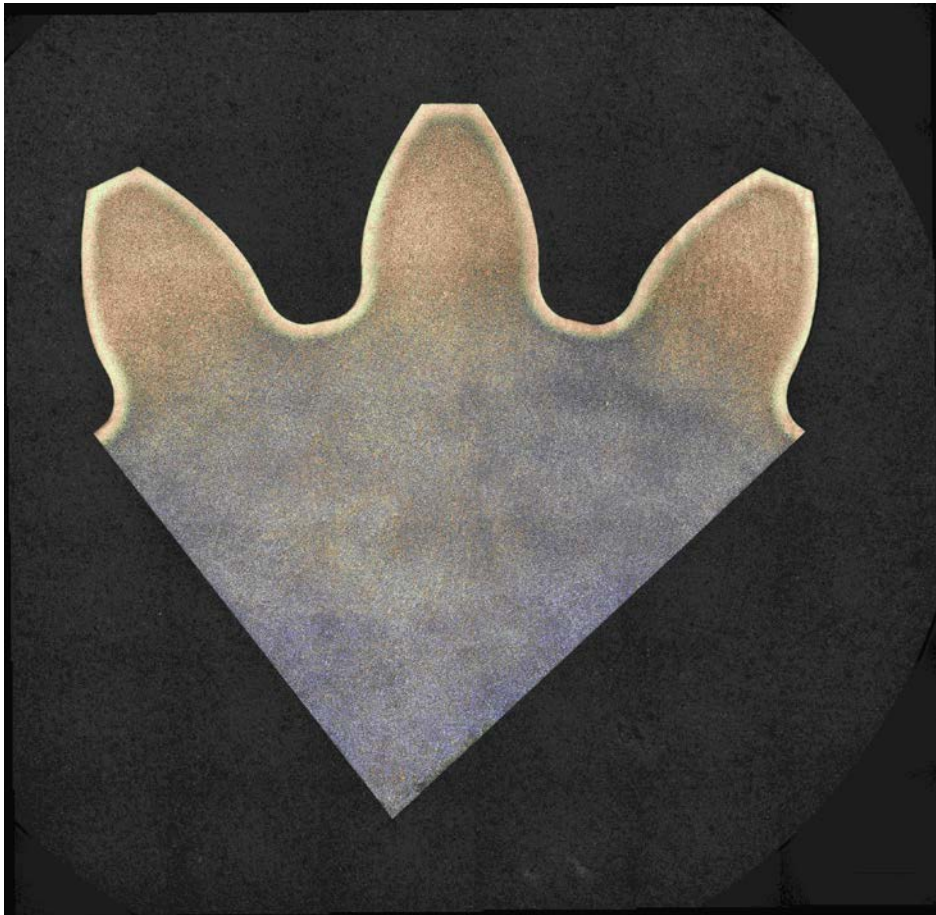


Figure 6: Micrograph of polished and etched portion of the pinion shaft and helical gear.



Figure 7: Micrograph of polished and etched portion of the pinion shaft and helical gear.