

NATIONAL TRANSPORTATION SAFETY BOARD

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



September 18, 2018

MATERIALS LABORATORY FACTUAL REPORT

Report No. 18-054

A. ACCIDENT INFORMATION

Place : Gainesville, Georgia
Date : April 28, 2018
Vehicle : Piper PA-28R-200, N4363F
NTSB No. : ERA18FA137
Investigator : Leah D. Yeager, AS-ERA

B. COMPONENTS EXAMINED

Cylinder number 2, left hand portion of the crankcase, and two broken pieces of the crankcase from a Lycoming IO-360-C1C engine, serial number L-15951-51A.

C. DETAILS OF THE EXAMINATION

Figure 1 shows a photograph of the as-received left-hand portion of the crankcase and the #2 cylinder that separated from the crankcase. The piston and connection rod arm remained attached to the cylinder. The end cap separated from the connecting rod arm. One of the attachment bolts for the cap was fractured at the shank portion and the other attachment bolt was not submitted (presumed missing). One half of the rod bearing shell was intact and the other half portion of the rod bearing shell was not submitted (presumed missing). The push rod for the #2 cylinder was intact and showed no evidence of damage. The bore for the #2 cylinder contained eight stud-bolts. The stud-bolts were arbitrarily labelled "1" through "8" in figure 2. The eight stud-bolts for the #2 cylinder were fractured at the thread portion.

The fractured ends of the eight stud bolts for the #2 cylinder were saw cut from the crankcase to facilitate examination and cleaning of the fracture faces. The fractured ends of the stud bolts were ultrasonically cleaned with acetone. Scanning electron microscope (SEM) examination of the excised stud-bolts revealed the fracture faces of all the stud-bolts contained evidence of crack arrest marks consistent with fatigue cracking. Fatigue cracking initiated at multiple origins along the root portion of the threads. For stud-bolts "1" through "7", fatigue cracking extended between 75% and 90% of the bolt cross section. For stud-bolt "8", fatigue propagation was through approximately 30% of the cross section. Figures 3 and 4 show examples of fatigue cracking on the fracture face of stud-bolt 6. On this bolt, fatigue cracking emanated from multiple origins at the root of the threads on diametrically opposite sides of the bolt. Fatigue propagation was in the general direction indicated by arrows in figure 3 and terminated in the areas indicated by dashed lines. The areas between the dashed lines contained microvoid coalescence features typical of overstress separation.

Bench binocular microscope examination of the fractured attachment bolt for the cap revealed the shank portion showed evidence of a cup and cone fracture consistent with overstress separation.

Frank Zakar
Senior Metallurgist

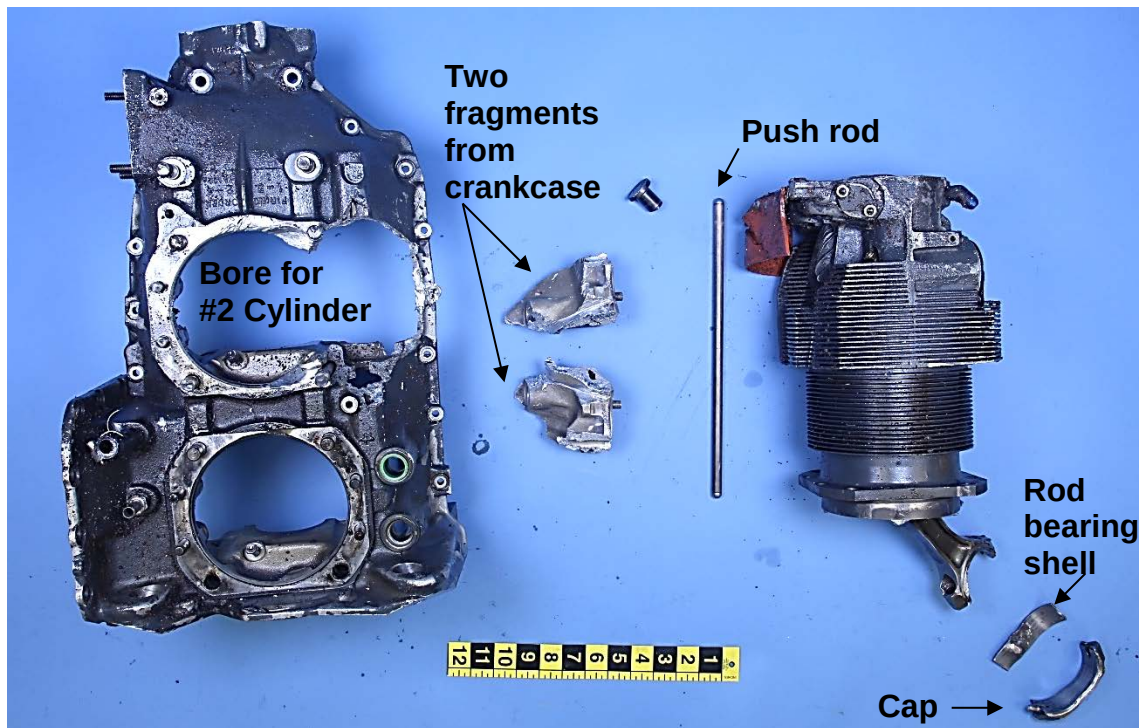


Figure 1. As-received left-hand section of the crankcase with two fragments of the crankcase (left and center of page); and #2 cylinder that separated from the crankcase (right side of page).

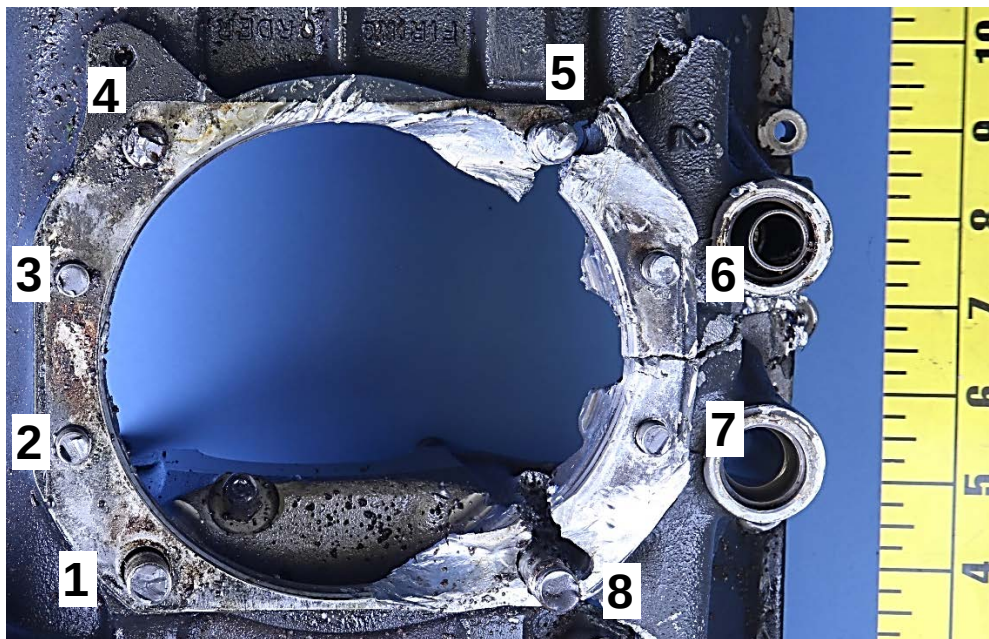


Figure 2. Close-up photograph of the crankcase bore for the #2 cylinder after the two fractured fragments of the wall were inserted into the bore as if intact. The stud-bolts arbitrarily labelled "1" through "8" were fractured at the thread portion.

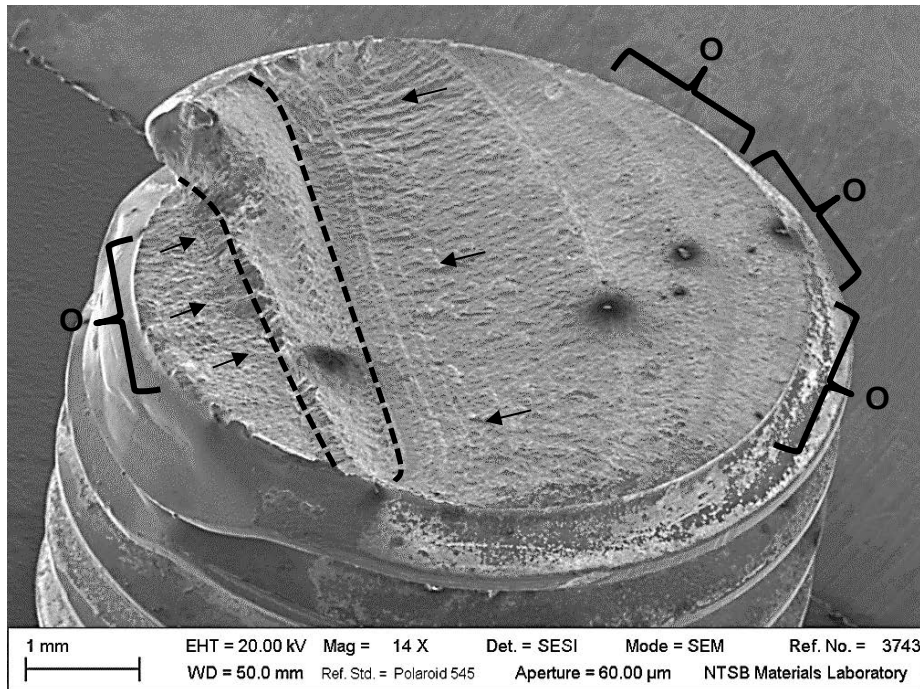


Figure 3. SEM image of the fracture face from stud-bolt 6 showing fatigue cracks that emanated from multiple origins at the root of the threads on diametrically opposite sides of the bolt in the areas indicated by bracket "O". The fatigue cracks terminated in the areas indicated by dashed lines.

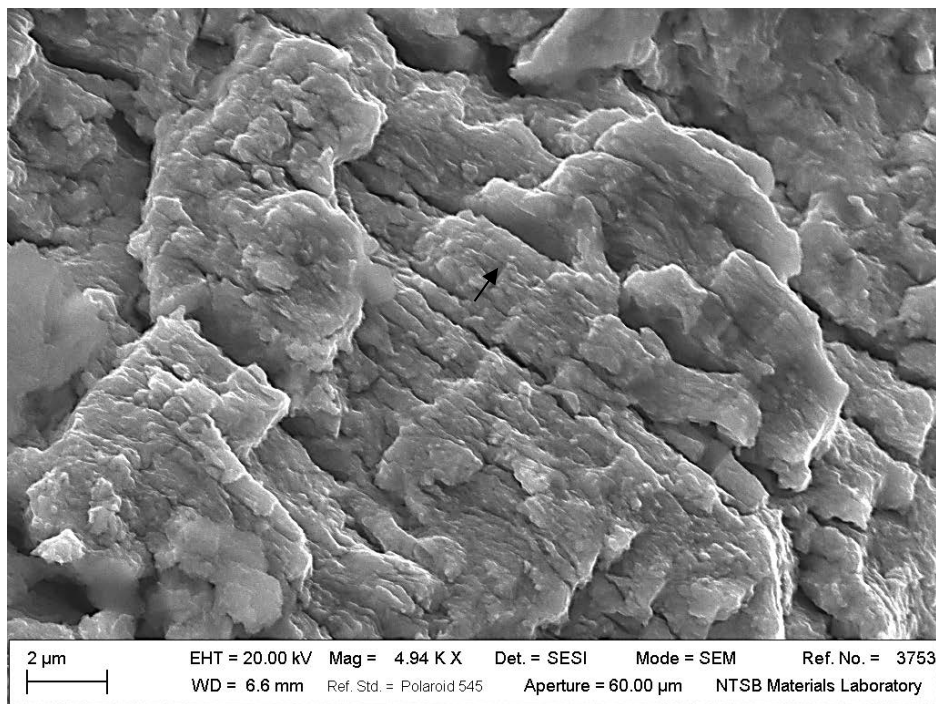


Figure 4. SEM image of typical fatigue striations with arrow showing general direction of fatigue crack propagation.