

NATIONAL TRANSPORTATION SAFETY BOARD

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



February 6, 2019

MATERIALS LABORATORY FACTUAL REPORT

Report No. 18-011

A. ACCIDENT INFORMATION

Place : Frederick, Maryland
Date : December 3, 2017
Vehicle : Cessna 180, N399F
NTSB No. : ERA18LA043
Investigator : Leah Read, ASI-ERA

B. COMPONENTS EXAMINED

Left main landing gear tire:

- Make/Model: Goodyear Flight Special II
- Retread: None
- Part number: 806C61-5
- Size: 8.00-6
- Serial number: 32112102

Wheel with fractured outboard rim;
Multiple fractured rim pieces;
Tire tube fractured into multiple pieces.

C. DETAILS OF THE EXAMINATION

A ruptured left main landing gear tire was submitted to the NTSB Materials Laboratory for examination. The tire was a Goodyear Flight Special II with alternating bias ply construction across the crown (the tread region of the tire). See Section B above for specific model and serial number attributes. The tire was reportedly placed into service in 2014. The as-received tire, still mounted on the wheel, is shown in figures 1a and 1b, for the serial side (SS – outboard side) and non-serial side (NSS – inboard side), respectively. For convenience, the tire was labelled with clock positions starting with 12 o'clock at the location of the serial number on the SS. Additional images of the tread are shown in figures 2a – d starting with the 9 o'clock position proceeding in 90° increments around the clock.

Visual examination of the tire revealed a fracture across the tire tread that generally followed one of the bias directions from approximately the 7:30 position on the NSS to the 10 o'clock position on the SS. The cords on the opposing bias were all fractured in this region. On the SS, the fracture continued circumferentially along the shoulder until it approached the 12 o'clock position at which point the fracture curved into the sidewall

terminating at the bead near the 1 o'clock position, as shown in figures 1a and figures 3a – d. On the NSS, the fracture continued following an approximately linear path terminating between the 5 o'clock and 6 o'clock positions, as shown in figure 1b and figures 4a – b. Finally, a circumferential fracture was observed branching off the bias fracture starting near the groove between ribs 1 and 2 at approximately the 9 o'clock position and continuing in the clockwise direction along the center of rib 2 (the middle rib) to approximately the 2 o'clock position.

Stereomicroscopic examination of the fracture surfaces revealed the presence of a comparatively smooth progressive fracture region along the bias ply fracture located along ribs 1, 2, and 3. The portion of the progressive fracture region near the NSS shoulder (at approximately the 8 o'clock position) is shown in the montage image in figure 5 with image annotations on the top and an unannotated version on the bottom. At this location, multiple curved crack arrest lines were observed in the rubber, two of which are indicated by yellow dashed lines in the figure. The orientation and curvature of the lines were consistent with cracks progressing from the cord region outward toward the outer running surface of the tread. Following the crack progression marks back to the origin indicated at least two crack origins where cords of the opposing bias plies crossed the fracture.

The progressive fracture region extended up to the white dashed boundary indicated in figure 5. Along rib 3, most of the progressive fracture region extended through approximately 50 percent of the rubber thickness except for an approximately 0.4-inch long region near the groove between ribs 3 and 2 where the progressive fracture extended completely through the rubber. Similarly, along rib 2, in the areas that could be interpreted, the progressive fracture region extended through approximately 50 percent of the rubber, increasing toward full thickness as the fracture approached the groove between ribs 3 and 2. Beyond the progressive fracture region near the NSS shoulder, multiple radiating crack lines were observed, several of which are indicated by yellow arrows in the figure, consistent with the onset of overstress fracture. The rest of the fracture in the tread region exhibited features consistent with overstress tearing.

Progressive fracture features were also observed near the groove between ribs 1 and 2, as shown in figure 6. The circumferential branching crack was located in this region and the fracture surface images were spliced together at the branching crack. Similar to the region described above, progressive fracture features were observed starting at the cords and progressing toward the tread surface. A white dashed line indicates the extent of the progressive features where their extent could be determined.

Stereomicroscopic examination of the remaining fracture surfaces revealed features consistent with tearing, cutting, and abrasion. Examination of the tire tube (see figure 5a) and fractured wheel outboard rim pieces (see figure 5b) revealed features consistent with overstress fractures. There were no notable tread wear patterns, cuts, or gouges on the tread surface. There was no evidence of rubbing or blue tinting to indicating a long-term internal separation.

Taken together the features were consistent with a progressive fracture through the rubber due to an overload failure of the underlying cords along one of the bias directions.

Donald Kramer, Ph.D.
Sr. Materials Engineer

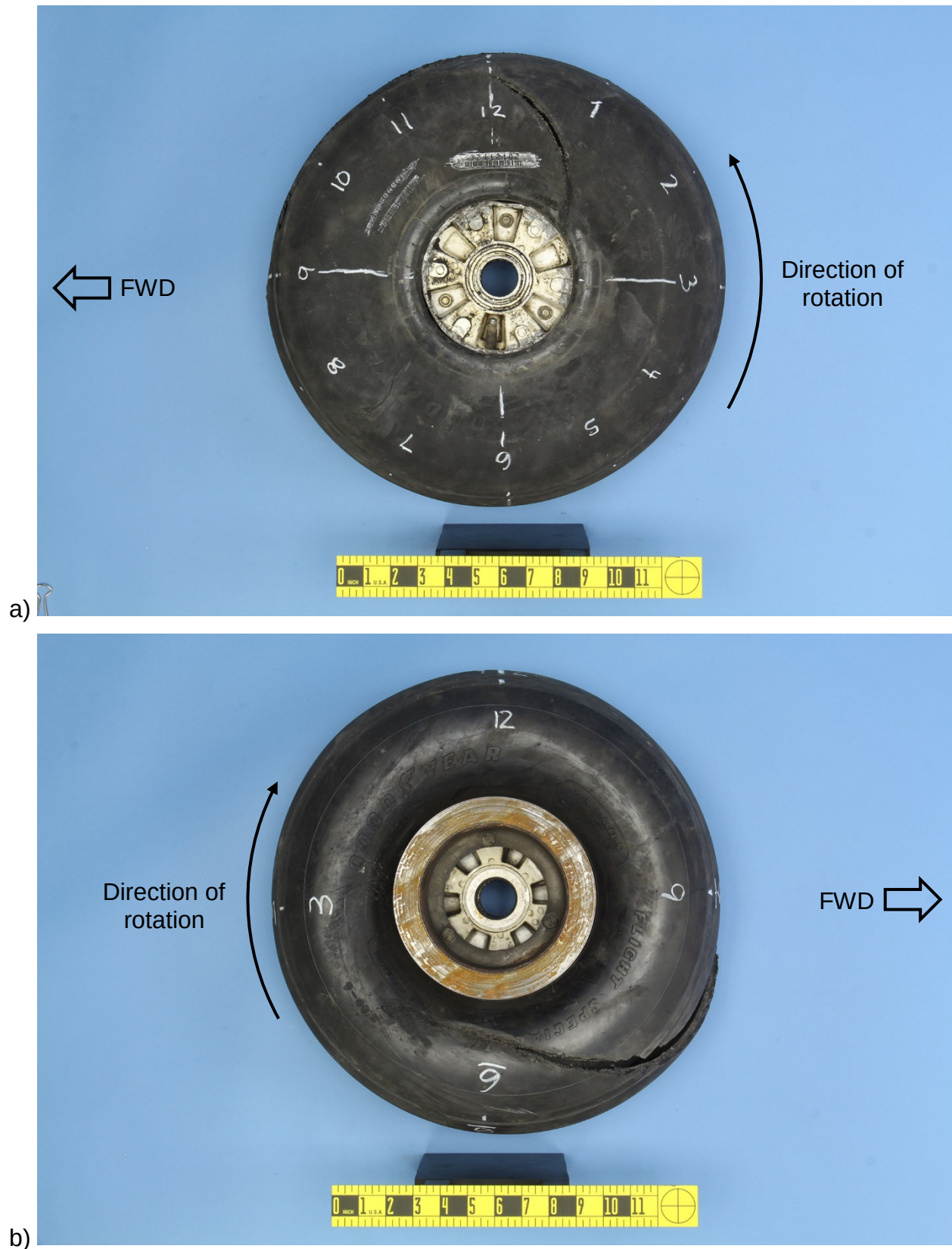


Figure 1: Images of the left main landing gear tire: a) serial side (outboard side); b) non-serial side (inboard side).

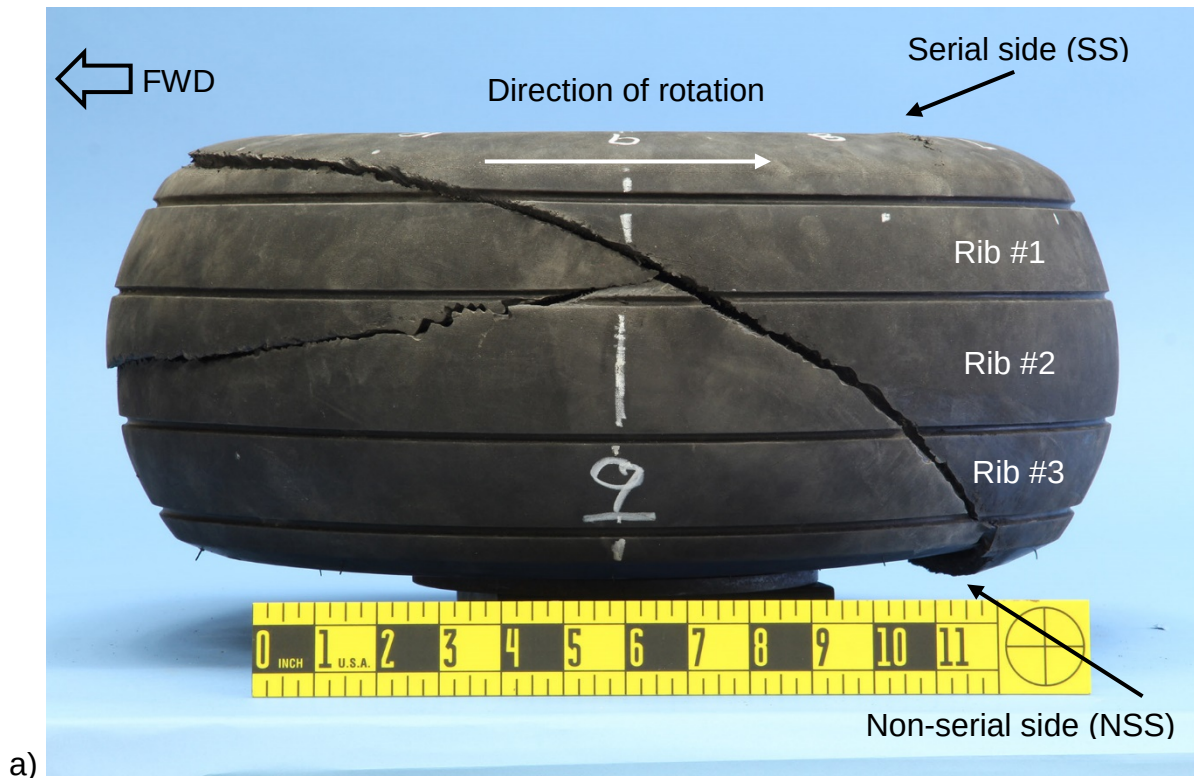


Figure 2: Images of the tire tread: a) 9 o'clock position; b) 12 o'clock position;



Figure 2 (cont.): c) 3 o'clock position; and d) 6 o'clock position.



Figure 3: Images of the fracture along the SS shoulder: a) between 9 o'clock and 10 o'clock; b) between 10 o'clock and 11 o'clock;



Figure 5 (cont.): c) between 11 o'clock and 12 o'clock; and d) between 12 o'clock and 1 o'clock where the fracture diverted into the sidewall.



Figure 4: a) and b) Images of the fracture along the NSS starting near the 7:30 position and ending near the 5 o'clock position.

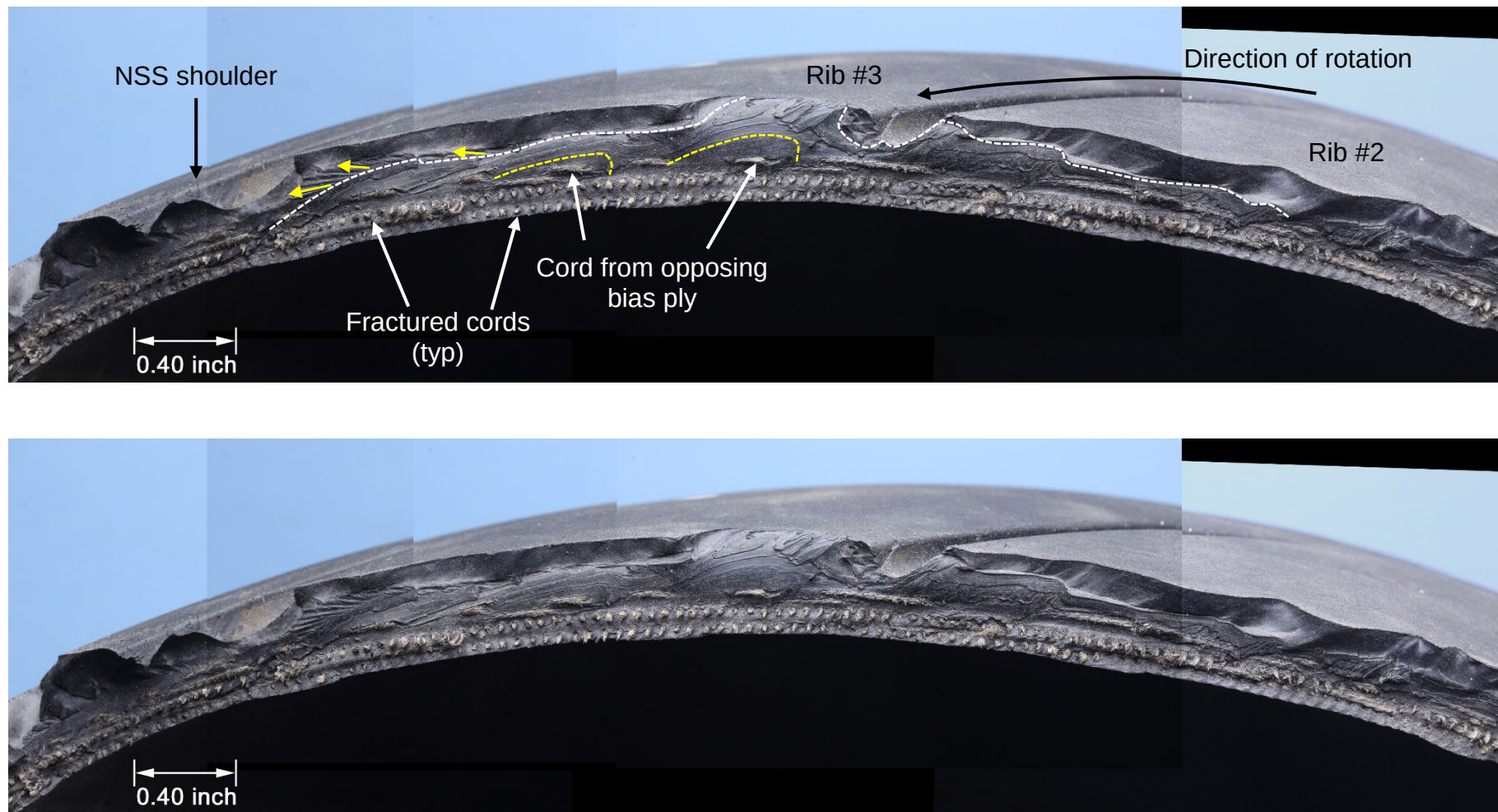


Figure 5: Montage of the fracture along the bias near the NSS shoulder spanning rib 3 and part of rib 2.

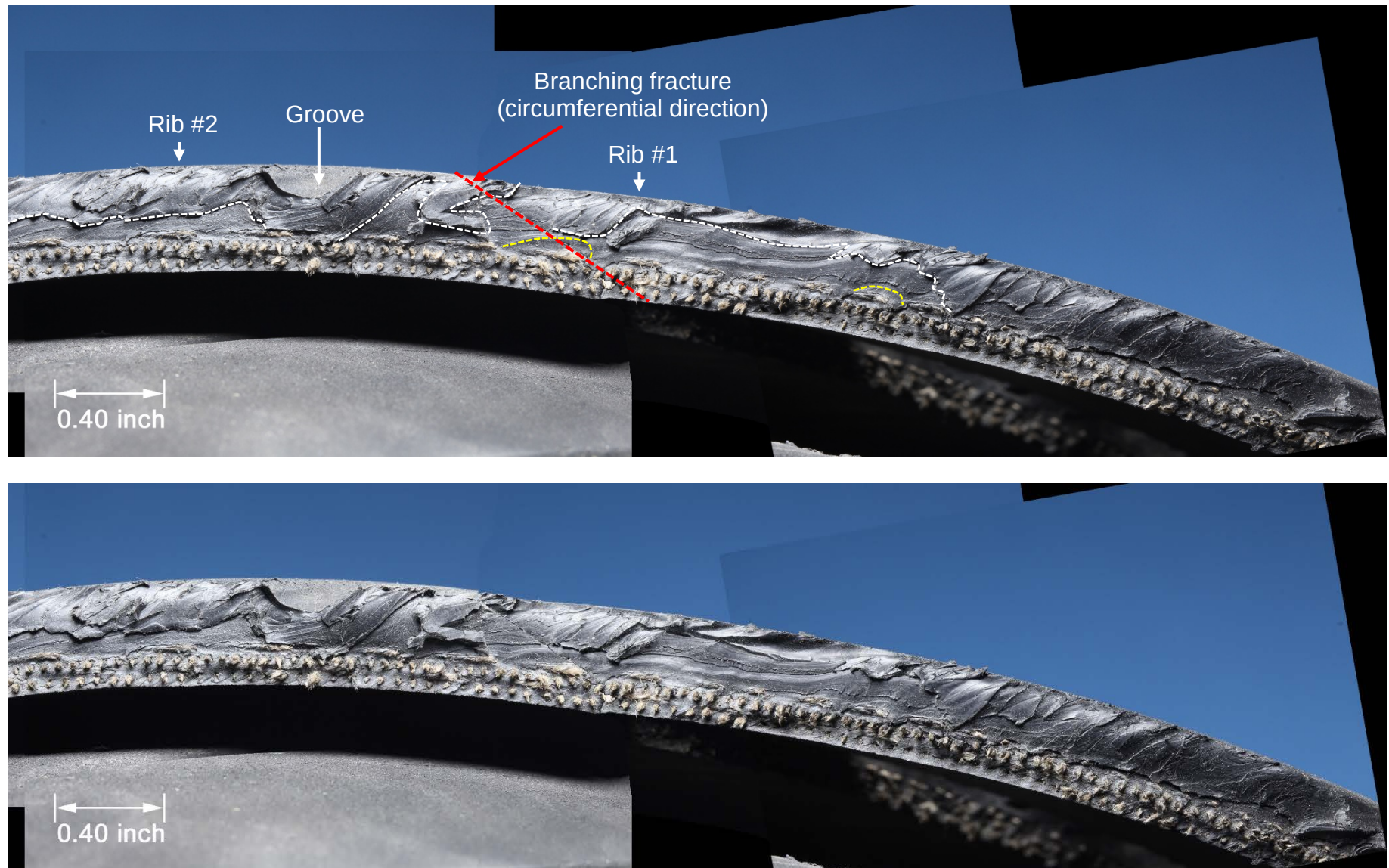
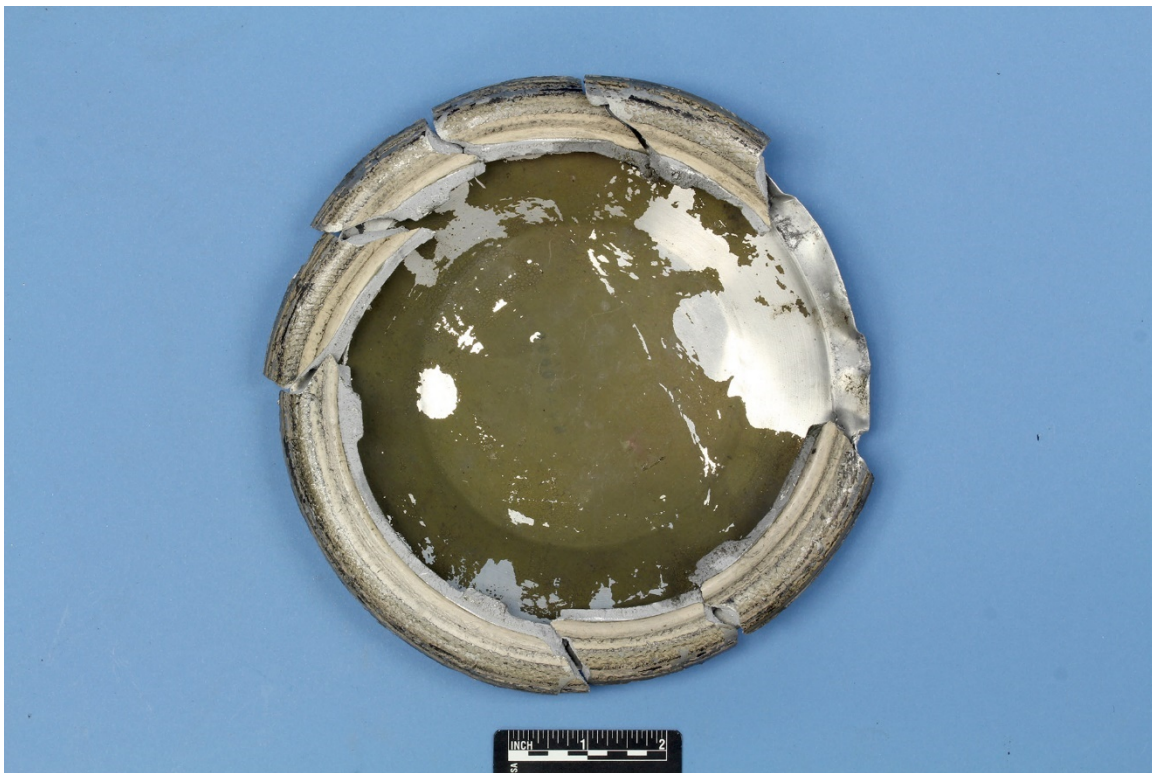


Figure 6: Montage of the bias fracture near the SS shoulder spanning ribs 1 and 2.



a)



b)

Figure 7: a) Image of the fractured tire tube and b) image of the fractured outboard rim pieces.