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Fractographic Examination of Sabreliner Landing Gear Fracture

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National Bureau of Standards
Washington, D. C. 20234

March 1, 1973

Failure Analysis Report

Prepared for
Bureau of Aviation Safety
National Transportation Safety Board
Department of Transportation
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U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary

NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

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1. GENERAL INFORMATION

1.1 Reference

Bureau of Aviation Safety, National Transportation Safety Board, Department of Transportation, Washington, D. C. Request by Mr. W. L. Holshouser, September 3, 1972.

1.2 Accident Identification

Sabreliner, NA265-40, N360N, White Plains, New York, August 28, 1972. NTSB accident No. NYC 73-I-N037.

1.3 Part Identification

A small part from a failed landing gear from the above mentioned aircraft containing part of a fracture face was submitted for examination. This part had been cut from a larger part of the failed landing gear. A photomacrograph of the fracture surface of the submitted part is shown in figure 1.

2. PURPOSE

The submitting agency requested a fractographic examination of the part.

3. EXAMINATION

The crescent shaped area of the fracture was very dark in color compared to the rest of the fracture surface. The dark area was the region of apparent slower crack propagation. The principal crack origin appears to be at the location indicated by the arrow in figure 1. At least one crack arrest line could easily be detected in the slower crack propagation region. There was a fairly sharp change in the fracture plane at the point where the slowly propagating crack front stopped and the rapidly propagating crack began (figure 2).

After visual and macroscopic examinations, the fracture surface was cleaned in an ultrasonic cleaner with water and detergent, and then examined with a scanning electron microscope. The crescent shaped portion of the fracture

surface was covered with a film which was probably composed of corrosion product. Examples of the film covered surface are shown in figures 3 and 4. The film was sufficiently thick in most areas to mask the features of the fracture surface.

In order to remove this film, the fracture surface was cleaned by replication (as for transmission electron microscopy). Replication was repeated until a clean replica could be removed from the fracture surface, indicating that no more material could be removed from the fracture surface by this technique.

The fracture surface was again examined with a scanning electron microscope. The fracture was still difficult to characterize because the effects of corrosion obscured some of the fracture features.

Near the fracture origin (locations 1 and 2, figure 1), intergranular cracking appeared to be the dominant fracture mode. Examples of this are shown in figures 5 and 6. In figure 6, the fracture features are less distinct than in figure 5. If intergranular cracking is indeed the fracture mode observed, then the probable mechanism of fracture exhibited in figures 5 and 6 is stress corrosion cracking.

There was some evidence of corrosion fatigue as shown in figures 7 and 8 (locations 3 and 4, respectively, figure 1). What appear to be striations can be seen in both figures.

The fracture surface in the faster crack propagating area beyond the crescent shaped area exhibited dimpled rupture as shown in figures 9 and 10. The mode of fracture here is ductile overload.

4. DISCUSSION AND CONCLUSIONS

As mentioned above, it is difficult to arrive at definite conclusions about the mode of fracture. The best interpretations of the scanning electron photomicrographs indicate that a crack, which originated at the location shown by the arrow in figure 1, probably started and propagated initially by stress corrosion cracking. It then grew by a combination of stress corrosion cracking and corrosion fatigue. When the crack had propagated to the end of the dark crescent region, the remaining cross section of the part failed from ductile overload.

There was a film, probably a corrosion product, on the slower crack propagating region of the fracture surface. Repetitive replication was, for the most part, successful in removing enough of this film so that some of the features of the fracture surface could be seen.

5. ACKNOWLEDGEMENT

Mr. D. B. Ballard of the Lattice Defects and Microstructures Section assisted in the interpretation of the scanning electron photomicrographs. Mr. L. C. Smith of the Mechanical Properties Section assisted in the specimen preparation for the scanning electron microscope examination.

Figure 1. Fracture surface of the submitted part as received. Arrow indicates fracture origin. Numbers 1 through 4 indicate areas of the fracture surface examined with the scanning electron microscope. X 6

Figure 2. View of the fracture surface showing the change in the plane of the fracture at the junction (arrow) between the slower propagating part of the fracture and the faster propagating part of the fracture. X 3

Figure 3. SEM showing fracture surface in slower crack propagating region before cleaning by replication. X 1375

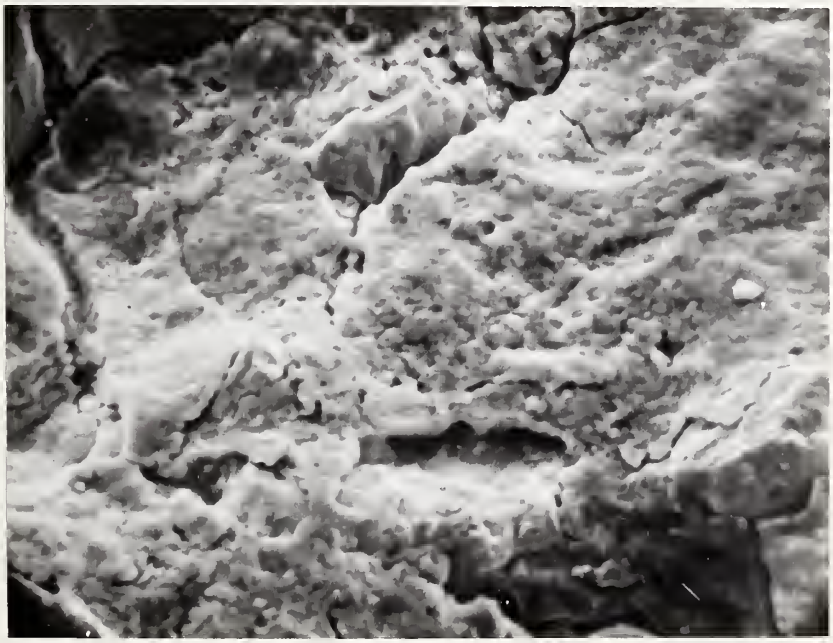

Figure 4. SEM showing fracture surface in slower crack propagating region before cleaning by replication. X 2400

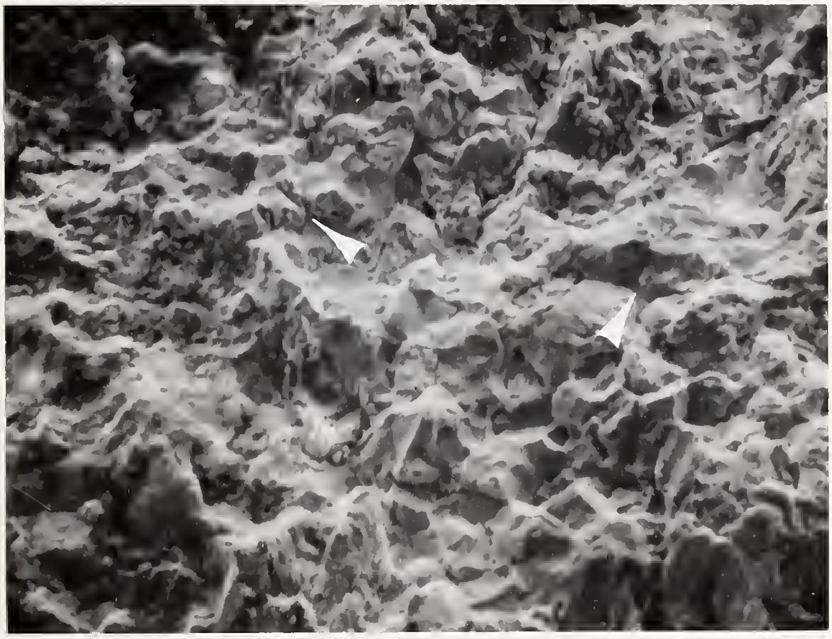

Figure 5. SEM from fracture surface at location 1, figure 1, showing apparent intergranular cracking as the dominant mode of fracture in this region. Two grain boundaries are indicated by arrows. X 1175

Figure 6. SEM from fracture surface at location 2, figure 1, showing apparent intergranular cracking as the dominant mode of fracture in this region. Two grain boundaries are indicated by arrows. X 1150

Figure 7. SEM from fracture surface at location 3, figure 1, showing what may be fatigue striations. X 1100

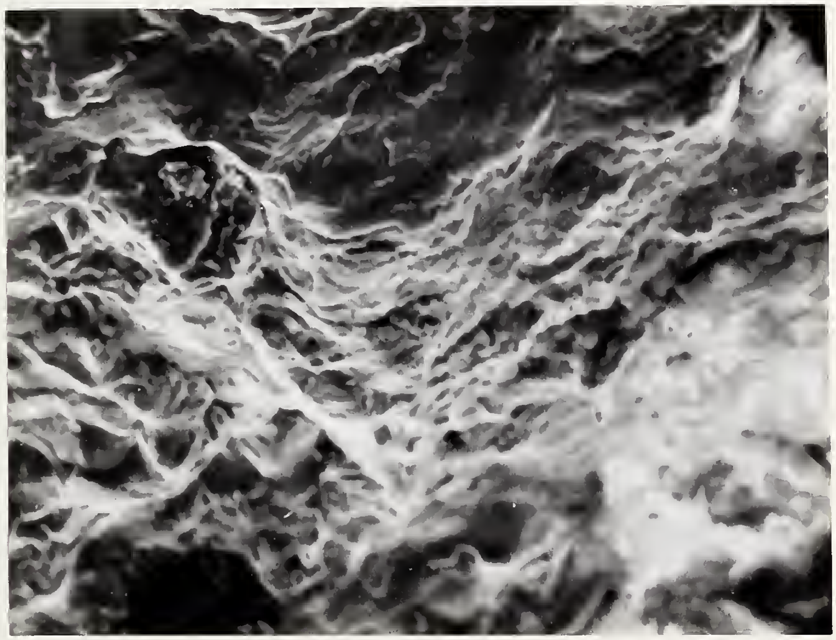

Figure 8. SEM from fracture surface at location 4, figure 1, showing what may be fatigue striations. X 2300

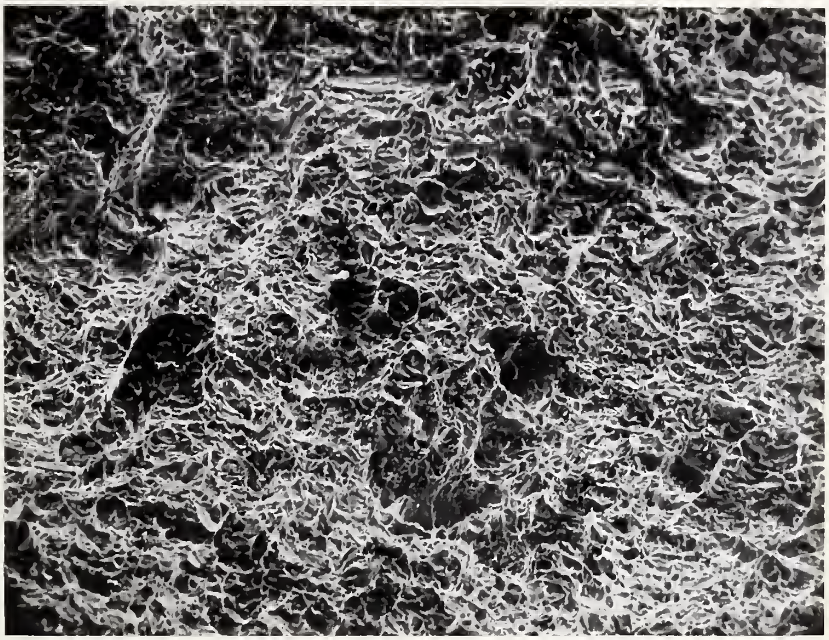

Figure 9. SEM from fracture surface in faster crack propagating region showing dimpled rupture. X 510

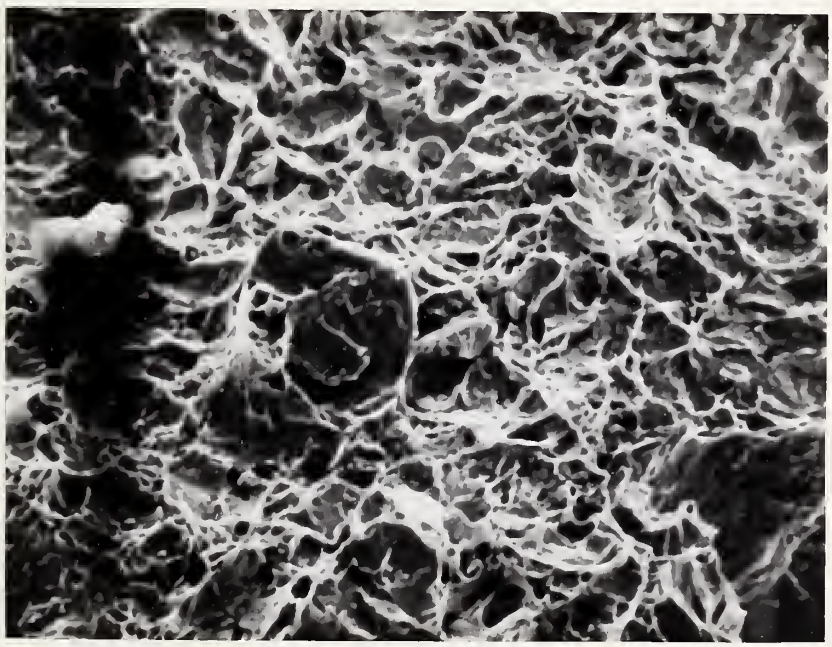

Figure 10. Part of field shown in figure 9 at higher magnification. X 2000

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15. SUPPLEMENTARY NOTES

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

Part of a fracture surface from a failed aircraft landing gear was examined with a scanning electron microscope. The fracture appeared to have initiated in stress corrosion cracking, and then propagated in a combination of stress corrosion cracking and corrosion fatigue. When the crack had propagated to the end of the dark, crescent shaped region, the remaining cross section of the part failed from ductile overload.

17. KEY WORDS (Alphabetical order, separated by semicolons)

Corrosion fatigue; fatigue; fractography; stress corrosion cracking

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