

Report on Fractured Leg Brace

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Conclusions

1. The brace failed as a result of a classical fatigue fracture.
2. The fracture began at a sharp notch (apparently a file groove) in the brace.
3. A notch at that particular location is extremely detrimental to the brace.
4. The brace would not have failed when it did had the notch not been present.

General

On 17 September, 1976, the failed aluminum leg brace seen in Figure 1 was delivered to me. I was asked to examine the brace, determine the cause of failure, and render an opinion as to negligence in design, manufacture, and repair.

My investigation consisted of a careful visual examination of the entire brace, optical and scanning electron microscope examination of the fracture surface, and a telephone interview of the plaintiff. I was not allowed to conduct any tests which would alter the state of the brace in any way.

Results and Discussion

Figure 1 is an overview of the brace, and Figure 2 is a close-up of the failed region near the fracture. The upper part of the fractured member is hidden behind the upper member in Figure 1. The slip lock on the upper member (slid up against the leather piece in Figure 1) may be slid down to fix the upper and lower member together in a rigid configuration. Figure 3 is a close-up of the front of the brace in the region of the fracture.

Fracture

Figure 4 is a close-up of the fracture surface to the left in Figure 2. The circular striations show that the fracture is definitely of the fatigue type. These striations encircle the origin of the fracture (like ripples around a pebble dropped in a lake) which is a notch, at the lower right hand corner (as seen in Figure 4). Examination of the front edge of the brace revealed a number of such notches (see Figure 3), which were apparently introduced by filing.

Such notches are known to initiate fatigue cracks and greatly accelerate fatigue failure. The notch could not have been at a worse place or in a worse orientation. The front surface of the member would be in tension, when walking, the tensile stress is a maximum at this point, and the notch is oriented correctly to imitate a fatigue crack. Good engineering and manufacturing practice requires that such notches be avoided in structures subject to cyclic (fatigue) loading.

Fracture

Examination of the brace showed evidence of such amateurish treatment that I thought that the user might have attempted repairs. I spoke to him on the telephone, and he denied making any repairs or alterations.

Both the upper and lower members show markings and grooves on the broad faces (some are visible in Figure 1). These would most probably be caused by gripping the member in a bare metal vise to hold the brace while bending it or making other adjustments. Three leather straps seen in Figure 1 are riveted to the brace. This was done in a very amateurish manner, as the surrounding aluminum was battered at the time the rivets were tightened. However, these defects were all on the broad sides of the brace members, which are not a critical stress area.

The real damage was done by whomever introduced the notches in the front edge of the failed member. This region (Figure 3) shows signs of having been filed (perhaps to allow the slip lock to slide down a little further). There are a number of notches, roughly parallel to the ground, on the front edge. (One of these initiated the fatigue crack.) These were caused by striking or rubbing the member with a sharp, hard object. It is quite possible that after the edge was filed, it was struck several times by the edge of the file. However the notches were introduced, they had the effect of sharply reducing the useful life of the brace.

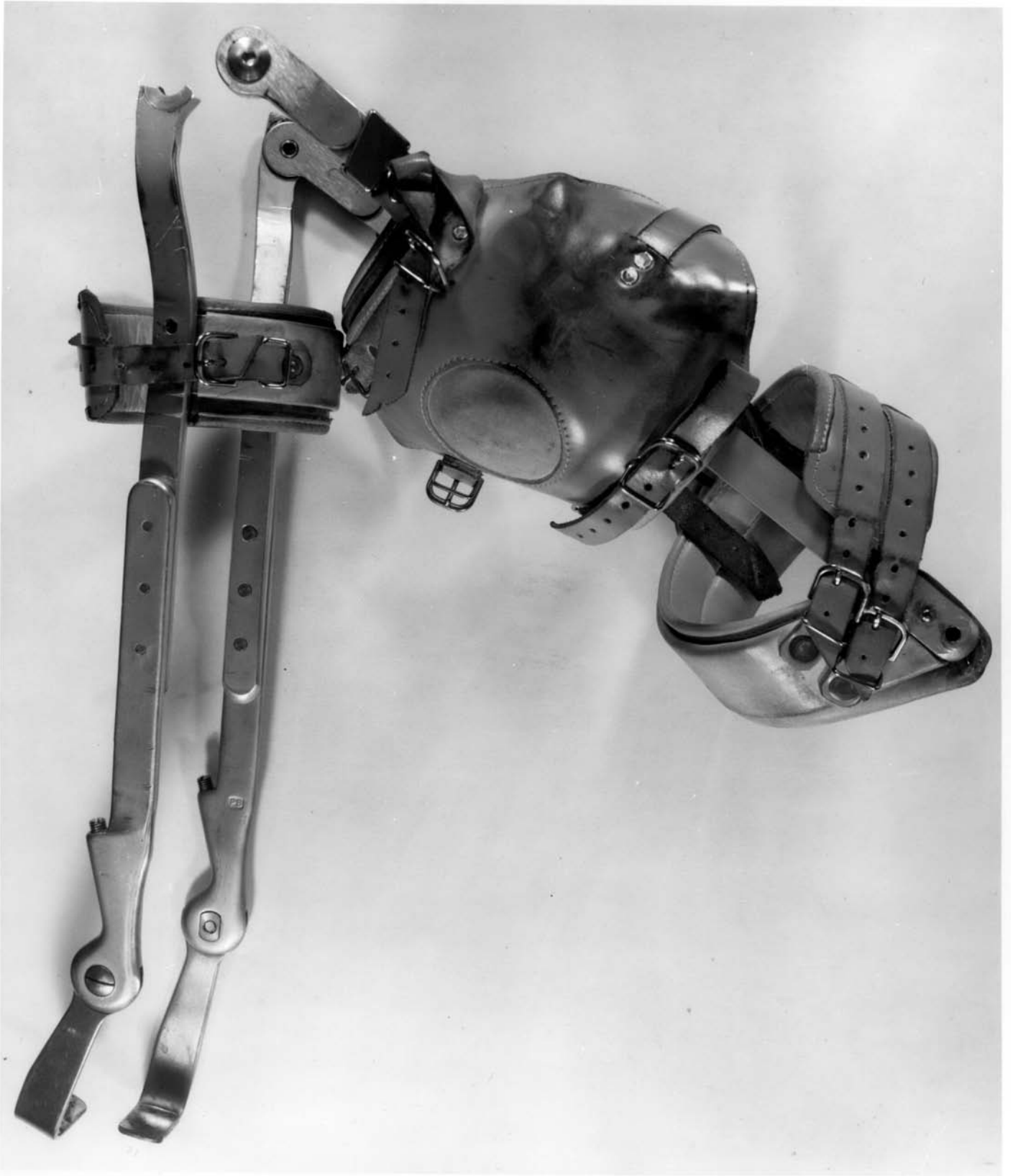


Figure 1: Failed brace, showing fractured member at upper left.



Figure 2: Close-up of side of brace in region of fracture.

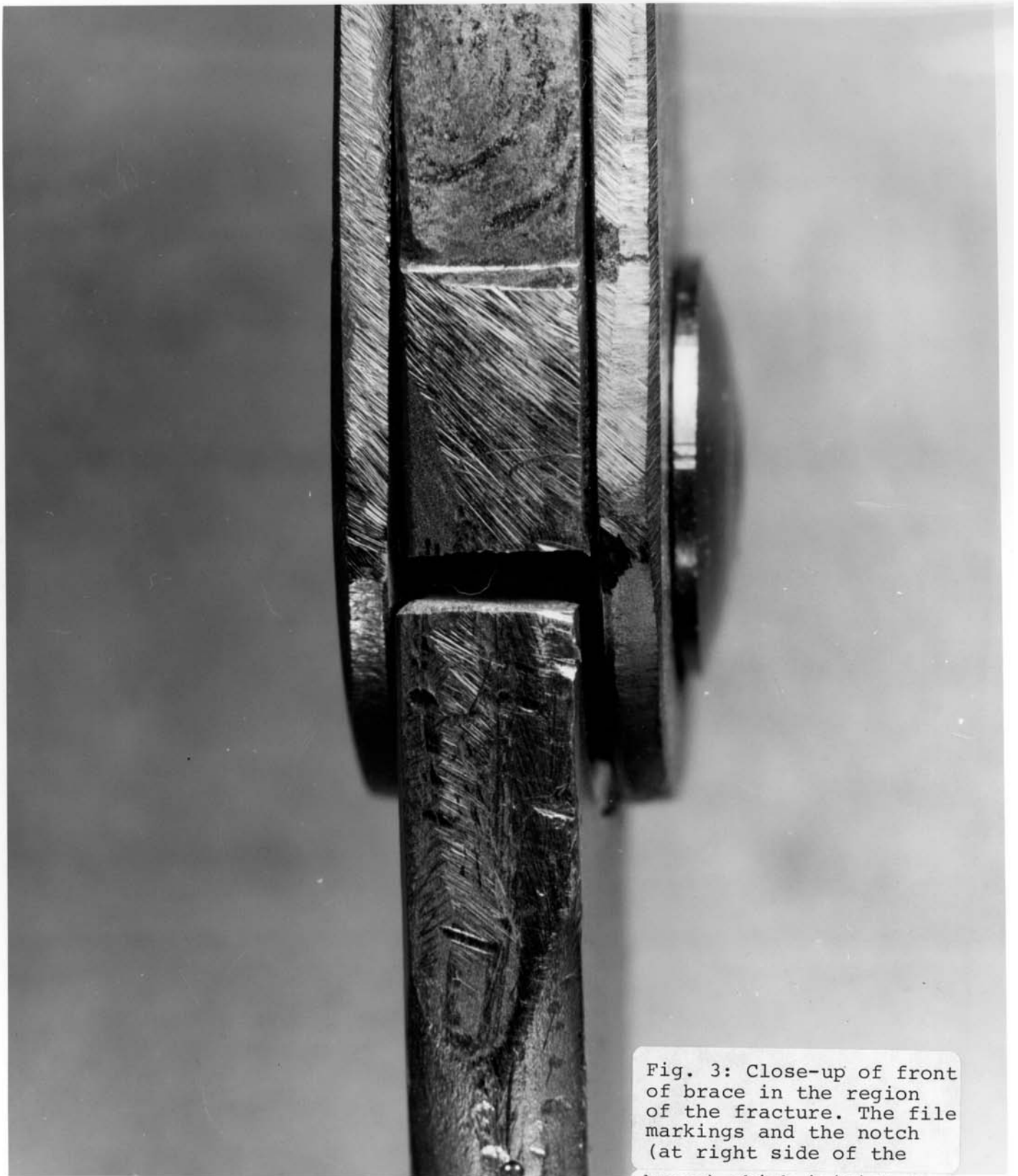


Fig. 3: Close-up of front of brace in the region of the fracture. The file markings and the notch (at right side of the brace) which initiated

Figure 3: Close-up of front of brace in the region of the fracture. The file markings and the notch (at right side of the brace) which initiated the failure are clearly marked.



Figure 4: Close-up of fracture.