

SOME AIDS TO REDUCE FAILURES OF ORTHOPEDIC PARTS

By FRANCIS L. SMITH, Fellow
With JOHN L. YOUNG, Ph.D., Senior Fellow

The Sarah Mellon Scaife Foundation's Multiple Fellowship on Orthopedic Appliances
at Mellon Institute, Pittsburgh, Pennsylvania

Most bracemakers have probably had the experience of making an orthopedic part for a number of years without any trouble and then suddenly they have a patient who keeps breaking a part over and over again. The final result is usually valuable time and money lost and a dissatisfied or lost customer.

A large number of these broken parts may be classified as fatigue failures. Fatigue failures generally plague any manufacturer that must constantly make a product as lightweight as possible. The aircraft and orthopedic industries definitely are alike in this respect. Lightweight but strong is easier said than done.

What causes fatigue failure? *First of all*, fatigue failures occur only on parts that are subjected to repeated loading. For example, the average man puts his weight on an artificial leg or leg brace about one million times a year. This is repeated loading.

Secondly, most fatigue failures involve a stress raiser such as is shown in the accompanying series of illustrations. Stress raisers give the same effect as increasing the load on part of the metal. Some people find it difficult to believe that a file mark, a scratch, or a hammer dent can eventually lead to the failure of a machine part. Of course, without experience, it is also hard to believe the story of the one rotten apple in a barrel.

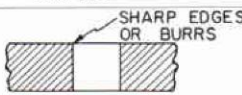
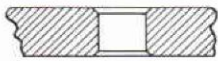
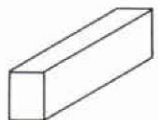
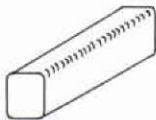
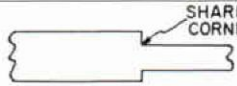

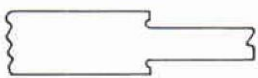
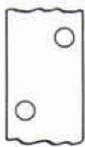
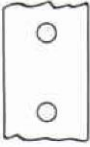


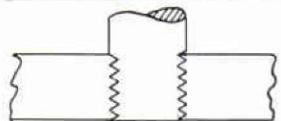
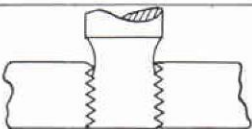




Thirdly, in order for the failure to occur, there must be stress in the area of the stress raiser. If the stress in this area is low, even a stress raiser cannot raise the stress high enough to

do harm. This is probably the main reason many people will look at the the illustrated examples, (see Table) and say, "I've been doing those things for years and never had any trouble."






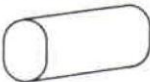


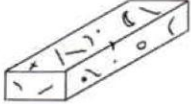
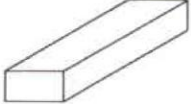
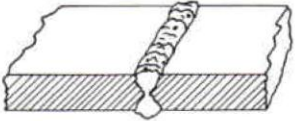
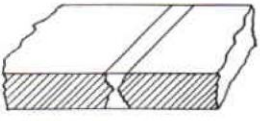




How can a fatigue failure be recognized? The answer can probably be best made by explaining how the failure occurs.

For instance, let us consider a side bar on an ischial seat leg brace. Every time the patient puts his weight on the brace the side bars are stressed. The back of the side bar is compressed and the front side of that bar is stretched or put into tension. Since fatigue failures are usually caused by tension rather than compression, the front side is the dangerous side. If this front side is polished smooth and the stress is not too large, no damage will be done. If the front side has a stress raiser on it, such as a sharp indentation, then whatever stress happens to be at the sharp indentation will be increased by two, or three, or maybe ten times. If, after this multiplication, the stress is still below what the material can take, no harm will be done. For the purposes of explaining the process, we will assume that the stress at this small pinhead area is too large. One grain or a small particle of the material will fail and the load it was carrying will have to be borne by the neighboring grains. Small individual grains will continue to fail, and eventually a crack, so small no method yet known can detect it, will form. This process, which may take a week, a month or a year to occur, only proceeds every time the man puts his weight on the brace. The initial crack

HELPFUL HINTS TO REDUCE STRESS RAISERS

CAUSE	REMEDY
 <p>SHARP EDGES OR BURRS</p> <p>1. DRILLED OR TAPPED HOLES</p>	 <p>REMOVE SHARP EDGES BOTH SIDES</p>
 <p>2. SHARP EDGES ON BARS</p>	 <p>REMOVE SHARP CORNERS</p>
 <p>SHARP CORNER</p> <p>3. SUDDEN CHANGE IN CROSS-SECTIONAL AREA</p>	 <p>USE LARGE FILLET IF POSSIBLE</p>  <p>IF SHOULDERS ARE NECESSARY</p>
 <p>4. OFFSET HOLES IN BARS</p>	 <p>PLACE HOLES IN CENTER</p>
 <p>SHARP EDGE</p> <p>5. KEYWAY</p>	 <p>REMOVE SHARP EDGE</p>
 <p>6. THREADED JOINT</p>	 <p>REMOVE MATERIAL ON BOLT. ANNEAL AND RETEMPER CUT TH'D</p>
 <p>7. SHARP BEND IN BAR</p>	 <p>MAKE BEND MORE GRADUAL</p>
 <p>JOHN DOE MAY 19, 1955 PART NO. 7</p> <p>8. NAME STAMPING</p>	 <p>DO NOT STAMP, USE STICK-ON LABEL</p>

HELPFUL HINTS TO REDUCE STRESS RAISERS

CAUSE	REMEDY
 <p>9. VISE CLAMPING MARKS</p>	 <p>PLACE SOFT COPPER ON VISE JAWS</p>
 <p>10. CRACKS IN PLATED OR SURFACE HARDENED PARTS</p>	 <p>PLATE OR SURFACE HARDEN AFTER BENDING</p>
 <p>11. FLASHING ON FORGING</p>	 <p>REMOVE FLASHING</p>
 <p>12. SHARP BEND IN CABLE OR WIRE</p>	 <p>MAKE BEND GRADUAL</p>
 <p>13. FILE MARKS, HAMMER MARKS, SCRATCHES, NICKS, ETC.</p>	 <p>MAKE SURFACE AS SMOOTH AS POSSIBLE</p>
 <p>14. WELDED JOINT</p>	 <p>MACHINE SMOOTH; ANNEAL IF NECESSARY</p>
 <p>15. ANY COLD WORKING</p>	<p>REMOVE COLD WORKING BY ANNEALING. RETEMPER IF NECESSARY</p>
<p>16. WELDING AND HEAT TREATMENT</p>	<p>FOLLOW MANUFACTURER'S RECOMMENDATION</p>
 <p>17. CRACKS DUE TO BENDING</p>	 <p>BEND AND ANNEAL IN STEPS</p>
<p>18. CHROME PLATING</p> <p>19. CORROSION</p> 	<p>BAKE IN OVEN 3 TO 4 HRS. AT 350°F</p> <p>USE ALUMINUM, STAINLESS STEEL, PLATED STEEL, OR SUITABLE NONTOXIC COATING</p>

