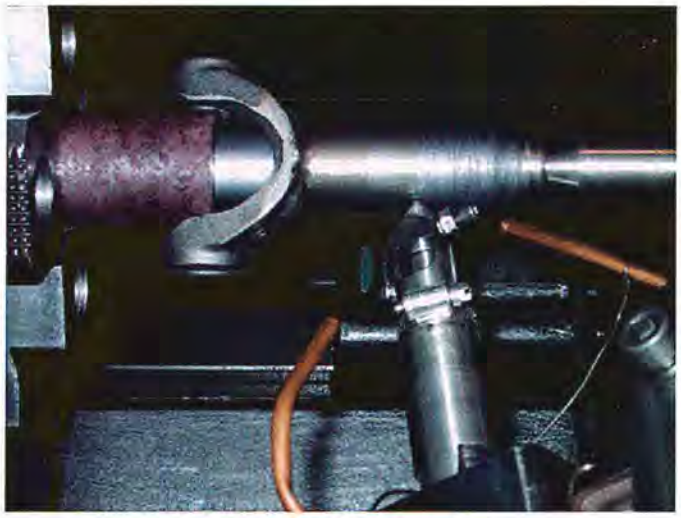
Fatigue Strength Improvement by Ultrasonic Impact Treatment (UIT)

by Dan Spinner, Applied Ultrasonics

Ultrasonic Impact Treatment (UIT) was originally invented to reduce welding stresses and deformations, introduce compressive stresses, increase corrosion-fatigue strength of welded joints and specifically enhance the fatigue resistance at subzero temperatures. In this vein, UIT has been used on bridge weldments in the U.S. when bridge repairs have been made, and in some instances, new bridge construction.



UIT Treatment of Ductile Iron Yoke

Enhancement of fatigue resistance of welded joints by plastic deformation of the surface, and by improvement of weld toe characteristics is well established. It is known that the conventional improvement techniques such as grinding, shot peening, air hammer peening, gas tungsten arc (TIG) re-melting, and welding consumables with improved weld toe characteristics can improve fatigue resistance of welded details. To-date, testing done by independent researchers has shown the results from UIT treated welds to be vastly superior to any of the other aforementioned techniques.

The principle of UIT is based on the instrumental conversions of harmonic oscillations of an acoustically tuned body into resonant impulses of ultrasonic frequency. The acoustically tuned body is brought to resonance by energizing an ultrasonic transducer. The energy generated from these high frequency impulses is imparted to the surface to be treated through the contact of specially designed steel pins. These transfer pins are free to move axially between the resonant body and the treated surface.

Depending on the desired effects treatment, a combination of different frequencies and displacement amplitude is applied. These frequencies range between 27 KHz and 55 KHz, with the displacement amplitude of the resonant body of between 22 and 50 microns. The controlled action of the application allows one to define the exact combination of effects, listed below, by altering and controlling the treatment parameters:

1. Formation of a white layer up to 10 microns in depth, with exceptional corrosion resistance, abrasion resistance, and lubricity.
2. Plastic deformation of the surface resulting in an introduction of compressive stresses to a depth of 3 mm.
3. Relaxation of tensile stress up to 12 millimeters in depth.
4. Altering the surface finish, resulting in a smoother surface and eliminating defects.
5. Improvement in endurance and corrosion resistance. Up to 250% and 400% respectively.

Other work on extending fatigue life has been done on various automotive drive components, wheel components, bridge repair, and brake drums and rotors for extended life. When there is a controlled application of UIT surface treatment for stress relief orintroduction of compressive stresses for fatigue life enhancement, UIT has consistently demonstrated the ability to out perform other technologies.

UIT Treatment of Grey Iron Brake Drum