Shot Peening FAQ

What is Shot Peening?

Shot peening is a cold-working method accomplished by pelting the surface of a metal part with round metallic shot thrown at relatively high velocity. Each shot acts as a tiny peen hammer, causing the surface to yield in plastic deformation and leaving a small concave depression in the surface of the metal. There are mechanical means of propelling the shot by use of a paddle wheel arrangement but most job shops use compressed air for its flexibility and minimal setup time.

What Does Shot Peening Do?

The depressions created by shot peening have stress characteristics similar to a flat bar being bent. In the case of the flat bar, the concave side of the bar is in compression and the convex side is in tension. The stress profile in the bar goes from maximum compressive stresses on the concave surface, to zero stress at the center, then to maximum tensile stress on the convex surface.

In the case of shot peening, maximum compressive stresses are at the surface, due to the deformation of the surface as opposed to bending. The stresses go to zero at the transition zone between the surface material, which has yielded to plastic deformation, and the material below, which has not. Below the transition zone the material is in tension. In a sense, the undeformed subsurface is in tension trying to pull the deformed compressed surface back to its original shape. This creates the necessary balance of forces within the component.

In most cases, the thickness of the material is much greater than the depth of the deformed surface, so there is a greater area to distribute the tensile stresses below the surface. This results in tensile stresses below the surface being of lower magnitude than compressive stresses on the surface.

What Is The Benefit?

Most fatigue failures occur due to loads that create tensile stresses, and tensile stresses are generally highest at the surface. By pre stressing the surface, any applied tensile load will first have to over come the compressive stresses in the surface before tensile stresses in the surface can be generated. This in effect creates an "overload" capability that the material did not have prior to shot peening. There is a lot of similarity to the concept of pre stressed concrete.

The use of shot peening in the right applications can result in a smaller, lighter component to carry a given load. In the realm of hot rodding, shot peening can increase the load capability of a given design and preclude the need for a heavier, more expensive replacement. When a component is on the margin of having enough strength to carry the required load, shot peening can improve the endurance and make it reliable.

Shot peening can mitigate problems due to stress corrosion and porosity in metals. In addition, the surface texture created by shot peening can provide a benefit in lubrication due to oil retention. Shot peening has also been used to relieve tensile stress in welds to improve fatigue life.

What Applications Gain Fatigue Strength Benefits From Shot Peening?

Almost any component subject to rotating or bending loads can benefit from shot peening. Some typical examples are:

- Axle Shafts
- Connecting Rods
- Crankshafts
- Gears
- Crankcases
- Rocker Arms
- Springs (Leaf, Coil, and Torsion Bar)

What Materials Benefit From Shot Peening?

Any metal component with a surface that can be substantially dimpled by the impact of shot can benefit from shot peening. Harder surfaces require higher velocities and larger shot, but there are limitations.

What Are The Limitations Of Shot Peening?

If a components surface is too hard, shot peening will not be effective. If the surface temperature exceeds the normalizing temperature of the metal, the residual compressive stresses will be relieved and the shot peening benefits will be lost. The surface being shot peened must be open to allow direct impingement (near perpendicular approach) of the shot. Blind surfaces may be impossible to effectively shot peen.

The shot peening process must be controlled. If the peening is too intensive, the depth of the shot peened surface will be excessive, which will create high tensile stresses below the surface. This can lead to cracks being initiated below the surface at stress levels lower than that at which cracks would have developed if no shot peening had been done. On the other hand, if the peening intensity is too low, insufficient compressive stresses will result and the potential improvement in fatigue strength will not be realized.

What Is Involved In The Shot Peening Process?

Based on the material and geometric considerations of the component, the proper peening intensity and shot is determined from guidelines established by empirical testing. In the case of compressed air shot peening, air pressure and nozzle size will be adjusted to achieve the desired peening intensity, once shot size and type has been established. To be effective, the entire surface must be covered (shot impact areas must overlap) and surface coatings can be applied as a reference. Otherwise, the surface must be repeatedly peened. The repeated peening will not increase the depth of

penetration, in as much as that is controlled by the peening intensity set by the shot, nozzle size, and air pressure.

How Is Peening Intensity Measured?

The recognized standard for measuring peening intensity is the Almen test. The test uses standardized steel test strips, which are shot peen to 100% coverage. The shot peening causes the strip to bend in an arc and the height of the arc is measured using a standard gauge made for that purpose. The height of the arc in the test strip relates to the peening intensity. The shot peening intensity specification will call out a height of the arc in inches and a letter designation for the strip used, such as 0.014 A.

What about Surface Polishing?

Shot peening will usually give significantly better improvements in fatigue strength as compared to polishing. Polishing before shot peening is a waste of time in as much as it will be removed by the shot peening. A surface to be shot peened need only be smooth enough for the peening process to remove whatever marks are present. Polishing the surface after shot peening would only destroy the effects of shot peening, and should not be done.