1992081

SHOT PEENING — PROCESS BRIDGES

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Shot peening provides a large benefit in fatigue life or load range of metallic components. Lack of appreciation of this process is caused by lack of understanding of the steps and their relationships. See Figure 1.

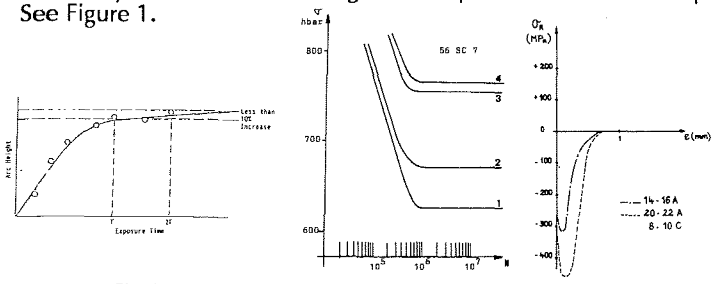

Fig. A. Fig. B. Fig. C.

Figure 1. Peening Process

The three basic diagrams used in shot peening are shown in the sequence of events. First, a recipe, shot size, velocity, impact angle, etc. is used to achieve intensity of peening. The peening then instills a compressive stress into the surface of the metal component. The metal component now has enhanced performance as shown by the S/N cycle to failure curve.

Under ideal conditions, a manufacturer could request a load capacity for expected fatigue cycles (Figure C). The metallurgist then specifies the (compressive) stress profile needed (Figure B). The shot peener than selects the shot size, intensity and coverage (Figure A).

Portraying each of these steps is not difficult. Understanding how each step affects the next is a challenge. A library of relationships helps to show dependent relationships. A peening model would be a tremendous help.

The design engineer should be able to specify the magnitude and depth of compression needed to give the intended results. The process engineer should be able to provide the peening "Recipe" needed to give the required stress profile.

Although we don't hear much about the two bridges (process engineer and design engineer), there are things we can do to help quantify the process. It is common practice to specify dominant process variables to the peener, such as shot type, hardness and size, peening intensity and coverage. One step that is often omitted is a definitive method to determine intensity and coverage. Most people assume that declaration of intensity is sufficient for the recipe. An area that could tolerate more attention is the Almen strip set-up, both initial development by the OEM and later by the overhaul facility.

Recent developments in process measurement provide display of shot velocity at the nozzle. This provides projected energy. Because distance and angle will reduce this energy level prior to target impingement, the energy must be measured again, this time using the Almen strip. This provides received energy. While it is common to place the strip in a "representative position", this is not always possible due to part geometry. It is these conditions that warrant special attention, especially if the OEM assumes that an overhaul facility will "correctly guess at a simulated position". If the Almen strip is placed at a greater distance or angle, then the received energy reading will require a higher projected energy to achieve the specified intensity. Situations where this occur include small slots and holes where the standard Almen strip cannot be fitted into a scrap part. These situations then normally proceed to provide an estimated position, sometimes using sub-size Almen strips.

If the sub-size strip is used, then the intensity must be referred to this strip. It is important that the strip is fabricated to well defined specification of hardness and flatness, preferably similar to the standard Almen strip. The modified Almen gage must also be constructed and maintained in a well defined condition.

HELP

Do you use sub-size Almen strips? We want to talk to you. Do you make them or buy them? How do you gage them? Call The Shot Peener at 1-800-832-5653.

The use of Almen strips to provide a measure of (received) energy helps establish intensity accuracy and consistency. It is vitally important that the procedures, standard or modified, be will defined and adhered to. If this is accomplished, then transition to a stress profile can begin.

The depth of the compressive stress, and its magnitude, are influenced predominantly by the peening intensity. Secondary variables, such as shot size and hardness, also influence these values. A large library of stress profiles has been compiled by The Shot Peener. The peening recipe is given for each stress profile.

HELP

Do you have a library of stress profiles (with peening parameters)? Please call The Shot Peener at 1-800-832-5653. We want to collect more data. If necessary, we can suppress your company's identity if your data is confidential.

Short-cuts: Investigation of affect of peening intensity on fatigue life can reveal optimum peening conditions. Figure 2 illustrates the improvement to stress corrosion cracking achieved by various intensity peening. Although this technique eliminates the second phase investigation (stress profile), it is economical and can be satisfactorily beneficial. Unfortunately, it doesn't help us understand the mechanics of the process whereby we could construct a model.

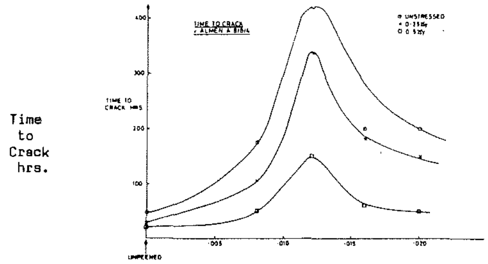

Figure 2. Peening Intensity

Advanced work is in progress that allows fast and accurate non-destructive indication of compression depth. This data can be tabulated in a library to provide the bridge information needed between stress profile and S/N fatigue life.

HELP

Do you have a library of S/N curves with related stress profiles? Please call the Shot Peener at 1-800-832-5653. S/N curves with peening parameters are also of interest.

Conclusion:

The three focal points of shot peening, intensity, stress profile, S/N curve, are bridged by the process engineer and design engineer. Empirical data showing the relationships between the stages can be utilized to provide the component manufacturer his desired load or cycle life.