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On-Site Shot Peening Considerations and Variations

LARGE PARTS FAIL in fatigue for the same reason as small parts. Hundreds of thousands to millions of load cycles cause surface cracks to initiate and grow. Cracks commonly originate at changes in surface geometry with some applications having an added corrosive element (stress corrosion cracking).

When parts have large dimensions, significant weight, or are installed on foundations, it is not practical to ship to a shot peening job shop. On-site shot peening is an excellent solution for these situations and is available in several forms to meet customer requirements. Some common on-site applications include aircraft, welded structures, power plants, refineries, and other processing facilities.

Similar to job shop shot peening, on-site shot peening offers significant longevity benefits to large components that are at risk of fatigue failure. Large equipment is very expensive and often times is custom designed which translates to long lead times for replacement. Shot peening significantly increases operating life and replacement costs are pushed far into the future.

Another large cost burden is equipment downtime. If the equipment being shot peened is essential to the operation of a power plant or other facility, downtime costs can be in the millions of dollars. Costs and timing associated with downtime are more critical when they happen on an unplanned basis.

This article will discuss some considerations and variations with on-site peening technology. One of the starting considerations when setting up an on-site project is shot containment. If a customer has an available blasting room that is suitable for the project, on-site time is reduced. Enclosing the peening area is commonly accomplished with a temporary tent for one-time projects. When peening the inside of a vessel, the walls act as a natural containment. Having fewer challenges with containing the shot presents other considerations such as confined space regulations.

Shot containment is most critical when peening fully assembled equipment such as aircraft. Needless to say, most all systems on an aircraft are not conducive to stray shot media.

The aircraft in Figure 1 required shot peening inside the opened section. The most important containment was preventing shot media from going inside the aircraft. The second priority was containment of shot to prevent any stray shot on the floor of the hangar.

A one-time project such as this is usually performed by an experienced operator with a manual operation. For

Figure 1: On-site shot peening of aircraft

projects that have repeating geometry and additional projects in other locations, usage of automation is preferred for the same reasons as automation in a job shop environment—improved setup and better repeatability.

One of the most effective tools for automation is the usage of robots. Robots are programmable for almost any component geometry and offer a wide range of motion to deliver the shot stream into necessary high-stress areas. Figure 2 on page 12 shows robotic peening of a challenging geometry. This customer had multiple on-site projects with the same peening requirements. A temporary enclosure was constructed for the first project to protect sensitive hydraulics and electronics while exposing the area to be peened. Follow-up projects utilized a more durable custom enclosure. The area requiring peening is the metal in the middle of the blue protected area.

When working on-site, a number of environments can be experienced. Matt Heschel, CWST's on-site shot peening manager, states, "Every job is the same in that we bring the service of shot peening to a customer's location. However, every project is different in terms of the circumstances presented." Some examples are:

- Language barriers
- Working high in the air on scaffolding
- Challenging weather when shot peening outdoor equipment
- Potential exposure to nuclear radiation thus requiring additional training and PPE
- Additional site time for safety training
- 24 hour per day and weekend coverage

Figure 2: Robotic peening of critical geometry

- Lots of pressure to complete projects ASAP that have expensive downtime, such as those in power plants

In addition to propelling and containing shot, another consideration is returning shot back to the machine. For a small project taking less than a day, it is likely best to have an operator refill the peening machine a few times. Larger projects require additional planning on shot return especially when re-filling the shot peening machine presents an efficiency bottleneck.

Another project consideration is the type of failure being addressed. For example, when an application requires more compressive stress depth than shot peening can produce, laser peening (LP) is an excellent tool. On-site LP has been available for almost a decade. It offers the benefits of a compressive layer than can be 10 times deeper than shot peening. With LP, containment of shot media is not a concern. In addition, LP follows a CNC peening spot pattern so that overspray is not a concern.

Curtiss-Wright Surface Technologies (CWST) has engineering services to support our customers' design efforts. CWST's laser peening group offers finite element stress analysis, simulation and life prediction capabilities. These analytical tools help customers perform cost benefit analyses of laser peening on new and service life extension projects.

An article in the Spring 2018 Shot Peener magazine described CWST's on-site laser peening of nuclear storage containers (see Figure 3). The deep compressive stress from laser peening the longitudinal weld seams is calculated to provide thousands of years of protection.

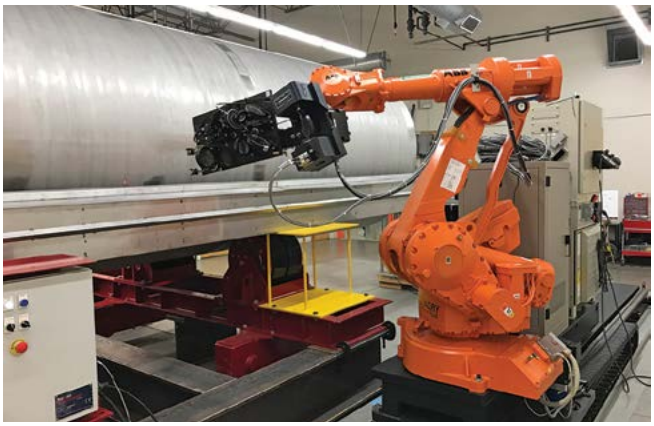

Figure 3: On-site laser peening of nuclear waste storage container

Curtiss-Wright Surface Technologies has the ability to send technicians for on-site shot peening at most locations worldwide. Adherence to the customer specifications and timelines are provided as part of the work scope. Additional technicians can be sent to support 24-hour coverage or work on multiple peening locations simultaneously.