Hardfacing Tips and Techniques

BY CHRIS MONROE

Increasing your equipment's resistance to abrasion and impact through the deposition of hardfacing alloys can save you time and money

Fig. 1 — The waffle pattern consists of a criss-cross bead pattern and protects against abrasive wear from smaller-grained aggregates.

Hardfacing involves the deposition of special alloys on a metallic part, using various welding processes, to obtain more durable wear properties. Hardfacing can increase equipment's resistance to abrasion and impact, and in some cases, specialized hardfacing alloys provide even greater resistance than the original part. Hardfacing protects equipment and its components against wear caused by impact and abrasion by using four weld bead patterns: waffle, herringbone, stringer, and dot. To determine which pattern or combination of patterns best meet your needs, you must consider the location of the wear, the type of wear, and the type of material that causes the wear.

What You Should Know About Your Base Metal

Carbon or low-alloy steels and austenitic manganese steels are the major types of base materials you can hardface. Materials containing a high carbon and/or alloy content, such as buckets or bulldozer blades, have a tendency to be brittle and are susceptible to cracks. You may need to pre- or postheat, slow cool, or stress relieve the welds to ensure that you have a solid, long-lasting weld. Preheating especially helps reduce cracks, distortion, porosity, and other weld discontinuities. Note: preheating temperatures are directly proportional to the carbon and alloy content of the base material — higher carbon contents require higher preheating temperatures.

Because of its high strength properties, manganese steel is among the most common materials used for crusher roll shells, hammers, impactor bars, and other equipment used in the mining and quarrying industries. There are, however, some important factors to consider before hardfacing manganese. First, be careful not to overheat the workpiece, as it can become brittle. As a rule of thumb, the temperature of the base metal should be kept below 500°F. Using a heat indicator stick is the safest and easiest method to determine a base metal's temperature.

Finally, to prevent overheating specific

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Fig. 2 — The herringbone pattern, shown on the side of this bucket, is formed by laying weld beads at varying angles.

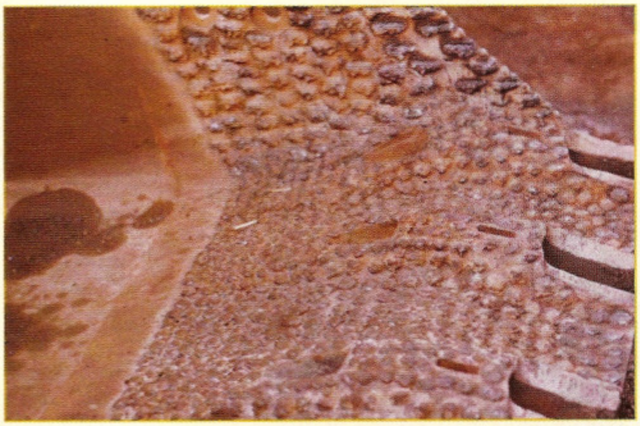

Fig. 3 — To produce the dot pattern, begin on the center of the workpiece and gradually fill in the spaces with additional dots until the area to be hard faced is covered with closely spaced dots.

areas when hardfacing manganese steel, distribute the heat from the arc across a wider portion of the work area by alternating welding locations on the component. Using higher travel speeds can also help reduce the heat-affected zone, which will minimize rapid cooling and prevent cracking.

Waffle and Herringbone Patterns

The waffle pattern (Fig. 1) consists of a criss-cross bead pattern that forms squares; you form the herringbone pattern (Fig. 2) by laying weld beads at varying angles. The waffle and herringbone patterns protect against abrasive wear from smaller grained aggregates such as dirt, sand, and gravel. By using the waffle and herringbone patterns, the aggregate packs between the hardfacing weld beads for excellent base metal protection.

In quarry and mining applications, the waffle pattern works well to protect crushers and rollers that are used to produce various sizes of aggregates. For example, on equipment producing ⅜-in. rock, apply parallel weld beads (or ribs) on the driver roll, spaced 1-in. apart, using multiple passes. The profile of the parallel weld beads should resemble a pyramid shape; apply more ductile hardfacing alloys to create the base of the pyramid and the hardest alloy for the peak of the pyramid. This parallel weld bead pattern provides a gripping action to force the rock into the crushing zone located between the idler and drive rollers. On the idler roll, deposit one weld bead that measures approximately 1-in. high in the form of a waffle pattern.

When producing larger sized aggregates, lay weld bead patterns on the idler and driver rolls spaced farther apart. For example, when producing ¾-in. rock, the ribs on the driver roll should be approximately 1½ in. apart and should form the same pyramid-shaped profile as described above. On the idler role, create squares in the waffle pattern measuring about 1½ in. across.

Fig. 4 — Stringer beads are weld beads that run parallel to one another and are suitable for certain buckets used on earthmoving or heavy construction equipment.

Dot Pattern

The dot pattern is the easiest hardfacing pattern to apply and is suitable for base metals that are sensitive to overheating. The dot pattern provides an effective wear pattern against low-impact, high-abrasive wear. To produce the dot pattern, begin on the center of the workpiece and gradually fill in the spaces with additional dots until the area to be hardfaced is covered with closely spaced dots — Fig. 3. Evaluate the amount of wear and use trial and error to determine the optimum amount of spacing between the dots.

Excellent applications for dot patterns include heat-sensitive applications such as manganese steel or thinner gauge metal where embrittlement is a major concern. The dot pattern also works well to protect parts against high abrasion commonly found on the scraper sides of earth-moving and heavy construction equipment.

Stringer Patterns

Stringer beads are weld beads that run parallel to one another and are suitable for certain buckets used on earthmoving or heavy construction equipment — Fig. 4. Stringer patterns run either perpendicular or parallel to the flow of the material, depending on the type of aggregate. A stringer pattern provides protection against abrasion and requires fewer pounds of hardfacing wire compared to the waffle pattern — a factor that can help lower costs.

To prevent wear on buckets caused by dry, larger-sized aggregates such as boulders, deposit stringer beads parallel to the flow of the material. This type of stringer pattern allows large aggregates to skim more easily across the hardfacing welds and protects the base metal.

Conversely, when working with smaller grained material such as dirt, sand, or pulverized coal, stringer beads should be placed ¼ to 1½ in. apart, with the weld beads perpendicular to the flow of the material.

Stringer patterns can also protect shovel teeth from wear. On shovel teeth handling large aggregates, place stringer beads that run the length of the entire tooth parallel to the flow of the material. When the tooth is used primarily for clay, dirt, and sand, deposit the stringer beads perpendicular to the flow of the material.

Hardfacing Tips

Base Metal Preparation. Whether you are hardfacing on carbon, low-alloy, or austenitic manganese steels, you need to clean your base material properly, ensuring that it is free of all contaminants, including grease, dirt, rust, and oil. Old hardfacing layers, as well as cracks, can be removed through arc (or plasma) gouging or grinding prior to adding new layers.

Control Your Arc Length. Possible causes of porosity when applying a hardfacing pattern include an excessive arc length and/or electrode extension (when flux cored arc welding), excessively wide weld bead width, and/or an overheated base metal. To prevent weld bead porosity, adjust the voltage or electrode extension and check to ensure that the work lead and ground clamp are securely attached.

Use the Correct Drive Roll Tension. When using FCAW wire, ensure that the drive roll tension is at the correct setting. Excessive tension deforms the FCAW wire, which causes poor feeding. Conversely, inadequate drive roll tension causes the wire to "slip."

Conclusion

Hardfacing can save you time and money by increasing your equipment's resistance to abrasion and impact. Repairing worn equipment and extending equipment life helps reduce the amount of downtime needed to replace broken or worn parts and eliminates the need to maintain a large inventory of spare parts. To ensure you are reaching the maximum wear resistance, evaluate the type and location of wear on your equipment and determine which pattern or combination of patterns works best to protect your equipment.◆