Problem Solving Forum

This Month’s Question

It is occasionally written that the use of steel shot alone creates a surface profile that is too rounded or “peened” for some coatings (e.g., inorganic zinc) and that an “operating mix” of shot and grit should be used. Is this true, and, if so, how is a proper operating mix selected?

From Kirt A. Clement and Jarvis J. Poche, Louisiana Department of Transportation and Development, Baton Rouge, LA:

Anyone interested in metallic abrasives should review Einer A. Borch’s chapter on “Metallic Abrasives” in Good Painting Practice, Steel Structures Painting Manual, Volume I, which summarizes the evaluation and use of metallic abrasives.

We will answer the question by presenting a case history of a bridge problem that occurred a few years ago and the changes that were made to rectify the problem.

During new construction, damaged coatings are spot-blasted and recoated with primer prior to topcoating. A problem developed when contractors were unable to “feather” the blast areas. An investigation indicated that similar problems were occurring on other new construction jobs. Adhesion tests were performed on the epoxy/zinc-rich system used on the projects, with adhesion results of greater than 400 psi (27 bar). However, cross cut adhesion tests performed according to ASTM D 3359 had adhesion ratings of 1B or 0B.

On some structures that were being constructed or had recently been painted with the same paint system, the adhesion problem was not occurring. Additional investigations revealed that the common link in the problem projects was mechanical abrasive blasting utilizing all shot abrasives. The projects where the problem was not occurring had utilized either mechanical abrasive blasting with grit or open dry abrasive blasting.

After consultations with mechanical abrasive cabinet manufacturers, we tried a working mix containing both shot and grit, and the adhesion problems did not recur. Soon thereafter, our standard specifications were amended to state, “When shot blasting is used, the abrasive mixture shall have a minimum of 25 percent by volume of approved grit material. The grit size shall be G-25 (SAE) with a minimum hardness of 45, Rockwell “C” range and abrasive mixtures shall produce an anchor pattern of 1 to 3 mils (25 to 75 microns).”

From David Hale, Ervin Industries, Ann Arbor, MI:

Interested persons should consult Volume I of the Steel Structures Painting Manual, Good Painting Practice. Chapter 2.2, “Metallic Abrasives,” includes an excellent discussion of this subject, excluding the coating issue. Included in the chapter are Scanning Electron Microscope stereo micrographs of profiles on steel blast-cleaned with both shot (about 45 Rockwell C) and hard grit (about 55 Rockwell C).

This question has 4 parts, which I will deal with in the following order: “operating mix,” profile produced by shot and grit, shot and grit mixes, and coating.

Operating Mix

During blast-cleaning, an operating mix (also called the “working mix”) of different particle sizes is created as the shot or grit naturally breaks down through impact on the steel and as it is recycled through the separator and impacts the steel again.

As new abrasive is added by the separator to replace the fine broken shot and contaminants, a stabilized mixture of sizes is created, ranging from new full-sized abrasive down to fines. The larger particles have enough impact energy to remove heavy rust and scale; the finer sizes scour pits and provide fast surface coverage and cleaning.

The size distribution of the operating mix is directly related to both the size and hardness of the new abrasive. Coarser new abrasive will produce a stabilized operating mix with coarser size distribution. Harder, more brittle abrasive will break down faster, producing a stabilized operating mix with finer size distribution.

Abrasive hardness also affects abrasive particle shape. Standard hardness cast steel shot and grit at 45 Rockwell C, with the lowest usage rates, produce stabilized operating mix with the coarsest size distribution. At this hardness level, a stabilized operating mix of grit will appear very similar to shot because grit is ductile enough that the initial sharp edges round over rapidly during impact.

Harder grit, at about 56 Rockwell C, fractures more rapidly during impact, producing a finer size distribution in the operating mix and retaining more sharp cutting edges during use. These harder, sharper particles will cut faster and remove the tougher scale on stainless and alloy steels.

It is important to emphasize that regular small additions of new abrasive must be added to the machine to maintain the size distribution of the stabilized operating mix.

Profile

Profile describes the number of peaks and valleys produced on the surface, as well as the shape and depth of the valleys. Profile is strongly dependent on the size distribution of the operating mix and the shape of the abrasive particle. A fine operating mix produces many more shallow peaks and valleys than a coarse operating mix.

Soft shot or grit, with the same size distribution in the operating mix, will produce the same profile size and shape. The profile will be rounded due to the roundness of the particles in the operating mix. Harder grit, with the same size distribution in the operating mix as the softer grit but with many more sharp continued
edges, will produce a profile with the same number of peaks and valleys; however, the shape of the peaks and valleys will be more angular and jagged.

**Shot and Grit Mixes**

Mixes of shot and grit, as described in the question submitted, would therefore be subject to all of the above considerations affecting size distribution of the operating mix and profile.

**Coating**

The question implies that a rounded profile is less suitable for good adherence of certain coatings. A recent survey of coatings manufacturers recently and found that very few had any profile requirements specified for their coatings. As a manufacturer and supplier of cast steel abrasives for surface preparation for coating, we know that shot, grit, and mixtures of shot and grit are commonly used.

The answer to this question could most likely be found in understanding the mechanism of adhesion or bonding to the blasted surface. If one accepts the concept that most coatings adhere to the surface through chemical attractions rather than through mechanical “anchoring,” then the shape of the blast particles probably has much less influence than the cleanliness of the blasted surface.

**Summary**

The profile of blast-cleaned steel is very dependent on the operating mix size distribution, abrasive particle shape, hardness, and new material addition rate. Coarser operating mixes produce higher profiles. Harder abrasive produces more angular profiles. Coating adherence may be more closely related to surface cleanliness than to profile. (Editor’s Note: Another factor that may influence adhesion is the increase in surface area created by angular abrasives, which can increase the number of bonding sites available to enhance adhesion.)

**From H. William Hitzrot, Chesapeake Specialty Products, Baltimore, MD:**

When steel alone is used as a cleaning media, the surface profile produced by shot is a fairly uniform, scalloped surface when viewed in cross section. With steel grit, these scallops are much less regular, resulting in many more actual peaks per linear inch of cross section and thus a less peened appearance. Given this observed difference between steel shot- and steel grit-blasted surfaces, blending the 2 into a working mix results in an increased number of peaks per linear inch compared to pure shot, providing an improved surface for most coatings.

I recommend adding at least 40 percent grit to the working mix. The amount of grit in the abrasive working mix can be varied from 40 percent grit:60 percent shot to 60 percent grit:40 percent shot.

Small additions of both should be added daily in the proper proportion to maintain the effectiveness of a grit:shot working mix. A grit:shot working mix combines ex-
cellent cleaning and provides good surface profile for most coating systems.

Reader Response

On Membranes for Bridging Concrete
From Bill Earl,
Porter International,
Houston, TX:

Cost-effectiveness of repairing and protecting concrete with a membrane (Problem Solving Forum, March 1990) may be achieved with proper installation of correct bridging and barrier compounds. First, consider the specification for repair.

The amount of movement (activity) of the cracks formed in concrete should be determined if possible. Having a background in physical testing always leads me to inspect the foundation and soil for movement caused by ground water levels into sand or clay.

A many-faceted approach to selecting a membrane for repairing concrete has been to investigate age, settlement, and end use. For a permanent, flexible adhesive or flexible caulk, organic polysulfide compounds and epoxy-modified, organic polysulfide blends can be used. These compounds cure to a pliable consistency or to a rubbery consistency with excellent adhesion to varied substrates. I highly recommend the organic polysulfide composition where conventional materials may be damaged or destroyed by spillage or by overflow of solvents or chemicals.

An extremely effective application would be caulking concrete storage tank rings and other cracks and then applying a laminate across the seal. The purpose of membranes is to cover or to line a substrate, and they should not be considered for use in a one-step application that will bridge active cracks and be used as an entire lining system. For immersion service, bridging is accomplished by filling the cracks with flexible adhesive that is tapered out above the adjoining surface. This is followed by a lining that increases adhesion and tensile strength. These same flexible compounds may be used by themselves in other exterior exposures if good ultraviolet light and chemical resistance are inherent to the compound.

The highest adhesive properties and tensile strength are not always prerequisites for a durable caulk-membrane combination. Butyl rubber has good adhesion to concrete and can be reinforced with fiberglass at 3/4 oz. (21 g) or 1-1/2 oz. per sq ft (42 g). An organic polysulfide blend that has a 25 percent elongation can be used in the cracks, followed with a butyl rubber membrane for low traffic applications.

These specialized compounds can be used as self-priming materials on properly prepared concrete to provide an extremely efficient moisture barrier. They also give quality protection from acids, alkalis, salts, ketones, and other chemicals. The system may have a high initial cost, but savings are made when further damage to concrete is eliminated by stopping leaks. This results in a positive effect on the environment along with increased life expectancy of the barrier system.

Why Trust Your Coatings Consulting Needs to Anyone But the Best?

KTA-TATOR, INC.

The Oldest...
Field test panel studies dating back to 1947; company establishment in 1949; on-site coating application inspection services beginning in 1961; inspection instrumentation sales beginning in 1965; training services in 1969; the establishment of an in-house physical testing laboratory in 1969, and in-house analytical laboratory in 1974 make KTA the most experienced coatings consulting engineering firm of its kind in existence.

The Largest...
Over 70 employees including professional engineers, chemical engineers, chemists, coatings specialists, and over 30 coating inspectors make KTA the largest coatings consulting firm in the United States. Regional offices located in Houston and Los Angeles allow KTA to service clients efficiently and effectively.

The Most State-of-the-Art...
Two modern laboratories devoted to coatings testing and coatings failure analysis. The analytical laboratory state-of-the-art equipment includes Fourier Transform Infrared Spectroscopy, Atomic Absorption Spectroscopy, High Pressure Liquid Chromatography, Gas Chromatography, Ion Chromatography, Photomicroscopy, and Lead Paint Testing. The physical testing laboratory equipment includes salt fog, QUV, Envirotest, Atlas Cell, condensing humidity, and production blast cleaning and coating application facilities.

The Best...
KTA history and field expertise coupled with in-house laboratory support make KTA the best.

KTA-Tator, Inc. — “Quality and integrity — Since 1949”
115 Technology Drive Pittsburgh, PA 15275 412/788-1300
Houston: 713/540-1177 Los Angeles: 818/713-9172

[Contact information and services offered by KTA-Tator, Inc.]