Controlling Surface Profile

What are the causes of surface profile exceeding specified ranges, and how can surface profile be controlled so that it meets the spec?

Hugh Roper

The most likely causes of excessive surface profile are improper abrasive selection for the equipment used, incorrect operation of the equipment, or improper blasting techniques. Here’s a good rule of thumb: if the existing profile is less than or equal to the specified profile, then the specified profile on both new steel and previously blasted and coated steel can be achieved by properly selecting and controlling the pertinent variables. Please note that existing profiles exceeding the specified profile are beyond the scope of this article and must be handled differently.

The rules for creating specific surface profiles with any abrasive blast procedure are derived from basic physics. Reference 1 details the variables involved in abrasive blasting, the interaction of those variables, and how to control each variable to consistently achieve the desired results.

To design an abrasive blasting process to meet a specification, you must know the condition of the surfaces to be prepared and the capabilities of the equipment to be used. To select a suitable abrasive and technique, it is prudent to run a profile test by a qualified blaster, using the project equipment to blast a surface with the same hardness as the project substrate.

Blasting techniques largely influence the productivity and profiles for any blast process. The equipment and blast techniques must be compatible with the selected abrasive. When using non-recyclable abrasive, blast at 90 degrees to the surface to hold the explosive energy at the surface and get the most work from the disintegrating abrasive. On the other hand, use recyclable abrasives at angles of 55–70 degrees to avoid the adverse effects of the vigorous rebound of recyclable abrasive. To improve the consistency of the profile, good blasting technique also includes a sweeping action (keeping the nozzle in constant motion) rather than focused blasting on a spot.

To remove an existing coating without increasing the surface profile requires adjustments to abrasive size and blasting technique. By using the smallest, hardest abrasive and by reducing the blast angle, there will be less indentation (decreased profile depth) while increasing scouring action to remove coating and corrosion products. The result of this scouring action will be increased peak count, which will improve coating adhesion.

The abrasive operating mix accomplishes the cleaning and profiling. If the mix is not clean, (free of dust and fines) or of the right type, mass (weight), hardness, shape, and friability for the project, then good results cannot be expected from the equipment or the blaster.

The particle size distribution of the operating mix is critical to achieving the proper surface cleanliness, profile uniformity, and peak count. It is important to establish the parameters for the proper operating mix and then maintain this consistency by an appropriate abrasive control process.

To illustrate the variation of operating mixes using steel abrasives, a properly controlled operating mix of a G 40 Grit produces over 475,000 impacts in a pound, while a pound of a G 25 Grit may only produce 180,000 impacts. It is the number of impacts that chiefly determines the quality of the cleaning.
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Because a surface profile that exceeds the specification may contribute to premature coating failure, controlling the profile during abrasive blasting is critical to the success of a coating project.

Many variables in the abrasive blasting process, both controllable and uncontrollable, affect profile. Controllable variables include the selection of the abrasive (particle size, particle shape, hardness, density, friability) and the blasting technique (nozzle pressure, nozzle wear, distance from the nozzle to the surface, angle of particle impact). Uncontrollable variables include surface composition, hardness of surface, mill scale versus coated surface, and existing profile.

Achieving the desired surface profile requires the expertise of a reputable abrasive supplier, an experienced contractor, and a knowledgeable specifying engineer. The involved parties must communicate effectively, from the development of the specification through the completion of the surface preparation.

A reputable abrasive supplier should control its manufacturing process to supply an abrasive with repeatable results. The supplier should be able to discuss all the parameters of the product and know what profile range to expect with a given abrasive size, the faster the cleaning and the lower the profile—provided that the abrasive has sufficient mass and velocity to break the scale or contamination and remove it.

The equipment, either air blast or mechanical, should have the ability to continuously ensure the proper velocity of the particles. Variation of particle velocity will have significant impact on both profile and cleanliness of the surface.

In summary, profile can be controlled to conform to a wide range of specifications, even when there is existing profile under a coating.


Hugh Roper is retired from Wheelabrator Abrasives, where he was responsible for technical services for all of North America and special assignments in South and Central America. He is a certified SSPC Coatings Specialist and a NACE Level 3 Coating Inspector technician.

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selected product gradation under standard blasting conditions. Abrasive gradation is one variable over which the abrasives manufacturer has control.

Many other abrasive product characteristics are inherent in the type or class of the abrasive. The abrasive supplier cannot change the particle shape, hardness, chemical content, or friability.

It is important to select an abrasive type that can create the specified profile. The contractor must overlook buying the abrasive based on the lowest price per ton, and instead, look at the characteristics of the abrasive in light of the desired results.

The contractor has several controllable variables with which to keep the profile in the desired range. The pressure at the nozzle is a key controllable variable. Higher nozzle pressure equates to increased particle velocity and faster production rates for finishing the job, which results in greater profitability.

Over the past decade, a trend for higher nozzle pressure has also affected the profiles typically achieved with standard sized abrasives. Profiles exceeding the specified ranges became the norm when applying higher nozzle pressure, resulting in an increased demand for finer grade abrasives.

On maintenance and repair blasting, some contractors still prefer a coarser grade abrasive, expecting to exceed the desired profile range because they believe a coarser abrasive achieves faster productivity. If they are challenged by an inspector, they re-blast with a finer grade abrasive to try to reduce the profile.

It has always been an industry assumption that this re-blast with a finer abrasive will bring the profile back down into the desired profile range. At best, you may be able to bring the profile down by a ½ mil by knocking off the high profile peaks, but it is almost impossible to change a 4-mil profile to a 2 mil profile with this technique.

This same potential problem exists if
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there is an excessive pre-existing profile under the existing coating being removed. The specifying engineer/inspector and the contractor must all be aware of the pre-blast surface conditions (rust pitting) and existing profile before a desired profile range is specified.

With so many controllable and uncontrollable variables, creating the desired profile is not an exact science. However, an acceptable result is obtainable through an understanding of all the variables and implementing proper controls.

Jeroen Keswiel, EUROGRIT BV, The Netherlands

An excessive surface profile is usually caused by using an abrasive that is too coarse. Selecting an appropriate abrasive size is the most important issue here. In doing so, you have to find a balance between cleaning power and surface profile. For a heavily corroded surface or a thick coating, you may need a coarse abrasive, but it will also give you a coarse profile. Sometimes it may be necessary to do a second (sweep) blast with a smaller grain size to reduce the surface profile to what is specified.

Another way to avoid excessive surface profile is to reduce the air pressure at the nozzle, thus reducing the impact of the abrasive on the surface (which reduces productivity).

Simply measuring the surface profile depth is not enough—it should be clearly indicated what type of surface profile is to be measured (Rt, Rz, Ry5, Ra, etc.) and how it is to be measured. Three methods for measuring the depth of the profile are described in ASTM D4417, Field Measurement of Surface Profile of Blast Cleaned Steel. Method A is a visual comparator; Method B is a depth micrometer; and Method C is a replica tape. All three methods are, in effect, differently defined, so the key is to reach agreement between the parties involved on which approach is to be used before beginning work.

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