Why Surface Preparation Is Important

Coatings experts often say that surface preparation is the most important part of a coating system. By this they mean that surface preparation affects the performance of the coating more than any other variable. Given that the proper coating system has been selected, if the surface preparation is poor, coating performance is usually going to be poor. If surface preparation is good, then the coating applied over it is likely to perform well. For you, the applicator, it is useful to know the reasons why surface preparation is so important, because knowing why can help you to do a better job.

Surface Preparation Is a Foundation

First, we can express the reason for the importance of surface preparation in a broad, general way, with the help of an analogy or comparison.

Surface preparation is to a coating system what a foundation is to a building. If a building has a poor foundation, it can list or lean, as the famous Leaning Tower of Pisa does, or it can collapse altogether. If a coating system has a poor foundation (surface

Figure 1 — Different degrees of surface preparation for steel
Courtesy of SSPC: The Society for Protective Coatings

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Table 1
Cross Reference Chart for SSPC/NACE/ISO Abrasive Blast Standards

Description	SSPC	NACE	ISO 8501 Standard
White Metal Blast Cleaning	SSPC-SP 5	NACE No. 1	ISO Sa 3
Near-White Blast Cleaning	SSPC-SP 10	NACE No. 2	ISO Sa 2 1/2
Commercial Blast Cleaning	SSPC-SP 6	NACE No. 3	ISO Sa 2
Brush-Off Blast Cleaning	SSPC-SP 7	NACE No. 4	ISO Sa 1

Figure 2 — Replicas of different surface profiles for concrete substrates
Courtesy of the International Concrete Repair Institute

preparation), it will fail sooner than expected (say, after 5 years rather than 10 years); or it can fail catastrophically, within the first year of application. In both instances, reduced service life and catastrophic failure, great financial losses occur to a facility owner. The contractor may be held responsible for these losses if the surface preparation work is found to be faulty.

But it is important to go beyond the general idea of a foundation when speaking about the function of surface preparation. Surface preparation creates a foundation in 2 important ways: mechanically, by providing an anchor for the coating; and chemically, by allowing intimate contact of coating molecules with the steel or concrete surface. These elements of foundation are best understood by their opposites—the negative conditions of slipperiness and debris.

Overcoming the Negative of Slipperiness

When a surface is very smooth, coatings have a difficult time adhering strongly. Imagine a coating on glass, for instance, and the ease with which it can be removed by a scraper or even a fingernail.

Imagine, on the other hand, a rough surface like sandpaper, and how difficult it would be to remove a coating film from it. When steel is abrasive blasted, it has a surface that is rough like sandpaper, with a series of tiny peaks and valleys called surface profile.

Coatings anchor themselves to the valleys of the profile, and the peaks are like teeth. This is why surface profile created by blasting is sometimes called an "anchor pattern" or "mechanical tooth."

Concrete is rough whether it is blasted or not, but blasting with steel shot or other abrasives is still helpful in creating a profile on the concrete for the coating to adhere to. Concrete needs to be blasted for other reasons, also, as explained later.

Overcoming the Negative of Debris

Debris on a steel surface can be made up of many different materials. On steel, debris includes dirt; dust; grease; oil; rust; moisture; and, in some cases, mill scale. On concrete, debris can include dirt, dust, grease, oil, form release compounds, curing compounds, and a loose layer of the concrete itself called laitance. When materials such as these are painted over, they interfere with both mechanical and chemical adhesion of the coating to the substrate and make it likely that the coating will fail.

On the other hand, when all debris is removed, the coating can achieve complete and continuous contact with the steel

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Table 2
ICRI Standards for Concrete Surface Profile (CSP) on Blasted Surfaces

Description	Designation
Light Shotblast	CSP 3
Light Scarification	CSP 4
Medium Shotblast	CSP 5
Medium Scarification	CSP 6
Heavy Abrasive Blast	CSP 7
Scabbled	CSP 8
Heavy Scarification	CSP 9

**From Guideline No. 03732, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, ICRI, 1997*

substrate, thus assuring the best possible adhesion. When a coating adheres well, then it is likely to be an effective barrier. The coating can minimize or prevent moisture from reaching the steel substrate. Remember, in the corrosion of steel, moisture is the electrolyte, and in concrete deterioration, moisture is often the penetrant that attacks the substrate.

Non-Visible Contaminants

Other forms of debris, not visible to the naked eye, are chemical contaminants. The most dangerous forms of chemical contaminants are soluble salts: chlorides and sulfates. When such contaminants are painted over, they have the power to draw moisture through the coating to cause blistering, detachment, and accelerated corrosion of the underlying steel or deterioration of the underlying concrete.

When structural steel is prepared for repainting, rough or pitted areas visible after dry abrasive blast cleaning may contain soluble salt contamination, especially in the bases of the pits. Dry abrasive blasting does not remove these salts, so it is wise to check for the presence of soluble salts with specially designed field test kits before painting and then to take additional cleaning steps to remove the salts, if they are present in detrimental amounts. Testing for and removal of soluble salts will be discussed in detail in a later Bulletin.

Degrees of Surface Preparation

In any job specification, the degree of cleaning required for a given steel or concrete substrate before painting depends on a number of factors. The service environment of the coating system is perhaps the most important, and normally is the first consideration when determining the degree of surface preparation required. Severe service environments include immersion in liquids, exposure to aggressive chemicals or environments, and high temperatures, or combinations of these conditions.

Various degrees of blast cleaning for steel are shown in Fig. 1 and Table 1. Figure 2 and Table 2 identify various profiles achievable with abrasive blasting on concrete, as recently established in a new technical guideline from the International Concrete Repair Institute (ICRI). (Of course, other surface preparation methods besides dry abrasive blasting are sometimes used for steel as well as concrete.)

A second consideration is the generic type of coating used. Some coatings, such as oils and alkyds, can tolerate application over minimally prepared or hand-cleaned steel surfaces, but alkyds should never be used over concrete because of the reaction that will occur between the alkyd and the concrete itself. Some epoxy mastics and other "surface-tolerant" coatings are formulated to be applied over hand and power tool-cleaned steel or concrete surfaces. Coatings such as vinyls and inorganic zincs, however, are at the other end of the spectrum. They require a higher degree of cleaning than many other types.

Cost is another factor in selecting degree of surface preparation. Generally

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speaking, the more rigorous the degree of cleaning, the more expensive it is. So blast cleaning steel to an SSPC-SP 5 (White Metal) usually costs more than blast cleaning to an SSPC-SP 7 (Brush-off). Similarly, blast cleaning concrete to a CSP 7 (Heavy Abrasive Blast) usually is more expensive than blast cleaning to a CSP 3 (Light Shotblast). In some severe environments and with some coating types, rigorous cleaning is necessary; but in other instances, cost-benefit in the form of longer coating lifetime will become an important factor.

Finally, regulations may have an impact on the degree and method of surface preparation. In residential or congested urban environments, open abrasive blasting may be prohibited; in addition, where lead- or chromate-based paints are being removed, hazardous waste regulations may require containment and use of special surface preparation methods.

Determining the degree of surface preparation, as described above, is the job of a specifier or engineer. The task of doing the work is the contractor's. No matter what degree of surface preparation is required, it must be done properly and thoroughly. If hand tool cleaning is required, then all the surface area specified must be hand tool cleaned. If SSPC-SP 5 is specified, then conformance with the written description of SP 5 must be achieved on all surfaces.

Following the Proper Sequence

It is also important to follow the proper sequence for surface preparation. For instance, when preparing steel, you must first remove dirt and other debris. It is a lot easier to sweep mounds of dirt and other loose material off a surface with a broom than to try to remove them with surface preparation tools. The next step is removing visible oil and grease with an emulsifier, which is a liquid that holds the contaminants in suspension and can then be washed off with fresh water. Then the operation of hand tool, power tool, or blast cleaning must be conducted.

The sequence for preparing concrete is similar. Dust and dirt must first be removed. Then, oil, grease, form release agents, curing compounds, and other chemical residues must be removed with steam cleaning, waterjetting, or detergent washing. (Other solvents are not recommended for removing these kinds of contaminants from concrete because they may carry the contaminants further into the porous concrete.) Muriatic or citric acid, grinding, shot blasting, or heavy abrasive blasting may then be required to remove laitance and to profile and finish cleaning the surface. If muriatic acid is used, special safety precautions must be followed.

If you reverse these steps, particularly with blast cleaning, the force of the blasting abrasive can drive the contaminants into the roughened surface or profile. Then the contaminants are not easy to remove, and they may interfere with coating adhesion.

In addition, it is important to achieve the surface profile required by specifications. When the profile is too rough, the coating may not cover the peaks of the profile. On steel, the result will be pinpoint rusting. On concrete, the result will be deterioration of the exposed peaks. When the profile is not rough enough, the coating may not anchor or bond well to the surface, and the result will be loss of adhesion.

Conclusion

To make sure that a coating system will provide the highest level of protection to steel or concrete surfaces, you must roughen the surface for mechanical adhesion and make sure that all debris is removed so that the coating contacts the surface.

In achieving these 2 conditions of cleanliness and profile, you will have created a proper foundation for application of a coating system. This good foundation should help to provide many years of service life for the coating. ❖

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