Surface Preparation for Galvanized Steel To Be Painted

Hot-dipped galvanizing is a long-lasting and cost-effective means of protecting steel from corrosion. There are, however, cases where paint or powder coatings are applied over galvanized steel to create what is known as a duplex system. A duplex system may be used as a means of adding color for aesthetics, camouflage, or safety; increasing the economic life of a structure; or increasing protection in very aggressive environments. Paint coatings can be applied soon after galvanizing, or later, when the galvanized coating has weathered.

As with all protective treatments of steelwork, surface preparation is critical. *JPCL / PCE* therefore posed the following question to Dr. Desmond Makepeace of the UK Galvanizers Association and John Krzywicki of the American Galvanizers Association (AGA): "What is the best surface preparation for galvanized steel to be painted?"

Both experts stressed the importance of identifying the stage of weathering of the galvanized (zinc) surface to be painted. Zinc reacts with the environment immediately upon removal from the galvanizing bath, eventually forming a tightly adherent, water-insoluble layer known as a zinc patina. The three stages of the weathering of the zinc are: newly galvanized (up to 48 hours after galvanizing); partially weathered (between 48 hours and 2 years after galvanizing—the zinc patina is only partially formed); and fully weathered (between 8 months and 2 years, with a completely formed zinc patina).

According to Dr. Makepeace, it is difficult to state the "best" surface preparation method because it depends on the age of the galvanizing and the degree of contamination. Instead, he discusses successful methods of pre-treatment before painting.

Pre-treatment of galvanized surfaces is best carried out immediately after galvanizing, before the surface has become contaminated by oil, grease, and dirt. Dr. Makepeace lists four methods of such pre-treatment: T-Wash (a trade name, but also used as a generic term), etch primers, sweep blasting, and weathering. Pretreatments either stabilize the oxides on a galvanized surface (e.g., T-Wash or etch primer) or remove loose oxides and slightly roughen the surface (e.g., sweep blasting).

T-Wash has been available for some time and is still generally considered the best pre-treatment method for painting newly galvanized steel, according to Dr. Makepeace. T-Wash is a modified, water-borne, zinc phosphate solution that contains a small amount of copper salts. Brush or spray applied, T-Wash visibly reacts with the surface, creating a dark grey or black discolouration of the zinc surface. This method should not be used on weathered surfaces, Dr. Makepeace says.

Etch primers have also been used successfully, he says. Besides being solvent-borne (and thus containing VOCs), he notes a major disadvantage as the absence of any visible color change when etch primers are applied. There can thus never be complete confidence that all surfaces have reacted with the primer. Etch primers, which can be spray or brush applied, are most suited to application on older, weathered galvanizing, but their use now is declining, according to Dr. Makepeace.

Sweep blasting consists of blasting the galvanized surface with fine copper slag, J blast, or carborundum powder at a blast pressure of no greater than 2.7 bar (40 psi). This ensures that only the minimum amount of zinc oxide is removed and that the surface is left in a slightly roughened condition. Angular iron grit should never be used to prepare galvanized steelwork because it may damage the zinc coating. Sweep blasting is most commonly used on newly galvanized steel due to the need for in-house facilities, Dr. Makepeace says. No standards for sweep blasting galvanized steel currently exist, however.

For fully weathered zinc, the surface may be hand-prepared with either abrasive pads or a stiff brush to remove all loosely adherent materials and to make sure that the bright zinc surface is not restored. This is followed by a hot detergent wash and a fresh water rinse. This method, however, is not, according to Dr. Makepeace, suitable for galvanized structures exposed in a marine environment with high chloride levels.

More recently, a proprietary water-borne, adhesion-promoting primer has become available for use on galvanized steel surfaces. This material dries to a hard, flexible, and nonporous film with excellent adhesion; can be topcoated by most paint systems; and has been successfully demonstrated on a number of galvanized structures, including the Forth Bridge, Dr. Makepeace says.

Mr. Krzywicki, marketing manager for the AGA, begins by stressing that the galvanizer should be notified before galva-

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nizing steel that is to be painted. Often the galvanizer will quench steel with water after it has been galvanized to facilitate cooling or will provide a thin passivation coating (by quenching the steel in water and chemical additives) to prevent initial corrosion during storage and handling. This step in the galvanizing process should be avoided when planning to paint because some types of passivation coatings, if not removed, can interfere with subsequent coating application.

According to Mr. Krzywicki, newly galvanized steel initially develops a thin, often invisible layer of zinc oxide corrosion products, but little or no surface preparation is required to remove oxides, especially if a slight profiling is employed to improve paint or powder coat adhesion.

Zinc oxide and hydroxides develop on partially weathered zinc. These ball-shaped particles are electrostatically connected to the steel surface. Mr. Krzywicki suggests, after cleaning the galvanized surfaces, removing the zinc oxides and hydroxides by sweep blasting (with an abrasive softer than zinc) or using an etch primer to slightly roughen the surface and improve paint adhesion. Solvents alone will not remove zinc oxides and hydroxides, he says.

When cleaning a galvanized surface prior to painting, the goal is to remove contaminants without removing too much of the galvanized coating. Alkaline cleaning, ammonia cleaning, and solvent cleaning are the most common ways of removing contaminants, according to Mr. Krzywicki. As some cleaners may react differently with different paint systems, the paint manufacturer should be consulted for specific reaction problems. After employing any cleaning methods, it is necessary to thoroughly rinse the surface with hot water and allow drying.

For the abrasive sweep or brush blast, blast material particle size should range between 8 and 20 mils (200 and 500 microns) and be propelled by a blast pressure of just 50 psi (350 kPa), Mr. Krzywicki says. Aluminum / magnesium silicate and organic media have been used successfully to sweep-blast galvanized steel, he notes. Mr. Krzywicki recommends a blast profile of less than 2.0 mils (51 microns).

The temperature of the galvanized part when blasting can significantly affect the finished surface profile, Mr. Krzywicki adds. A temperature range of 175 to 390 F (79 to 199 C), which exists as the newly galvanized steel cools, provides for an excellent profile. He recommends that ambient conditions for sweep blasting be less than 50% relative humidity with a minimum temperature of 70 F (21 C).

In fully weathered zinc, the patina has a very stable and finely etched surface, permitting excellent paint adhesion. According to Mr. Krzywicki, the only surface preparation needed is a warm-water power wash to remove loose zinc oxide and zinc hydroxide particles from the surface.

Mr. Krzywicki mentions two alternatives for preparing partially weathered galvanized steel that is to be coated—phosphating and acrylic passivation.

Iron or zinc phosphate treatments can increase the adherence and durability of the paint film; product manufacturers should be consulted for application specifics. Acrylic passivation (an acidic acrylic solution) also can be used to promote paint adhesion. Through immersion, the solution should be applied at approximately 0.04 mils (1 micron) thickness to a clean galvanized surface. Mr. Krzywicki says acrylic passivations are suitable substitutes for vinyl butyral acid-etch wash primers.