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Field Coating of Existing Thin-Walled Metal Structures

Revêtement de protection in situ des constructions en acier à parois minces

Beschichtung von bestehenden dünnwandigen Metallkonstruktionen

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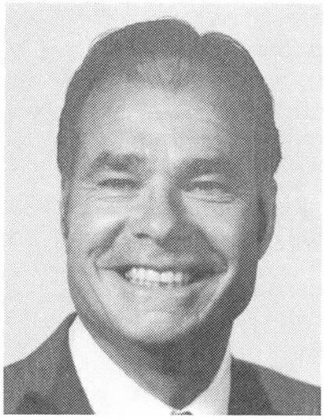

An Engineering graduate of Louisiana State University, USA, S.M. Cothren has been active as a Consulting Civil Engineer on a wide variety of civil projects since 1958. An important area of his practice has been in the inspection of various steel structures and tanks, followed by the preparation of detailed specifications for each individual project.

SUMMARY

An overview of the re-coating requirements and methods for restoring and maintaining the useful life and integrity of thin-walled metal buildings is given in a summary form. This paper is designed to serve as a general guide to the industry accepted procedures for various work activities in the recoating process. The activities covered herein are surface preparation, material selection and coating application.

RÉSUMÉ

Cette contribution donne un aperçu des conditions à requérir lors de l'application d'un nouveau revêtement et des méthodes de restauration et d'entretien à appliquer pour maintenir une construction en tôle mince formée à froid dans sa longévité et son intégrité. Son but est de servir de guide sur les procédés acceptés par l'industrie pour les différents travaux entrant dans le processus de rénovation des revêtements. Il s'agit en particulier de la préparation de la surface, du choix des matériaux et du mode d'application.

ZUSAMMENFASSUNG

Eine Übersicht über Anforderungen und Methoden für die Wiederherstellung und Erhaltung der Beschichtung von dünnwandigen Metallkonstruktionen wird in knapper Form gegeben. Das Dokument ist als allgemeine Richtlinie für die von der Industrie akzeptierten Methoden bei der Beschichtungserneuerung entworfen worden. In dieser Übersicht werden Oberflächenvorbereitung, Materialauswahl und Anbringen der Beschichtung behandelt.

1. INTRODUCTION

Beginning in the mid 1940's, metal building systems that were pre-formed and shop coated have made tremendous and impressive advancements in the building construction industry. The earliest memory most of us have of a pre-fabricated metal building is the Quonset huts used in World War II, some of which are still in existence today.

Advancements to this date in the industry give the buyer hundreds of choices in panel profiles, materials and coatings to choose from, and because of this, the thin-walled metal structure is seen in the use of thousands of different commercial and industrial applications from warehouses and schools to power plants and the petrol industry. With this advancement in uses, the need to understand the many coating systems is very important to the retro-fit industry, as well as the Architects and Engineers responsible for evaluating the need for, and method of, recoating these thin-walled metal structures.

The specifier must have a good general knowledge of metal structures, factory coatings, and proper methods of preparation for recoating with compatible materials.

2. DURABILITY

The most important characteristic of all building components is durability, which is defined as; the ability of the unit to meet or exceed a projected life span. Durability is very critical for thin-walled metal structures as the basic metal component usually range in thickness from 18 gauge to 26 gauge.

2.1 Thin Wall Materials

The metal in the structure can be copper, several types of steel and aluminum, to name the predominate ones. Each has specific areas of use and not all metals are suited to all environments. The most common preformed raw material is steel, and because of the inherent nature of steel to deteriorate from reaction with the elements, a proper coating, properly applied is the key to durability.

3. FACTORY COATINGS

3.1 Development

As a part of the manufacturing process, a factory coating is applied to the thin metal component. These systems are as old and varied as the base metal component. In the Quonset hut era, galvanizing was the industry standard. To improve appearance and marketability, red-lead primers on steel with colored enamels as the final coating were developed. These coatings were surpassed by the use of urethanes, epoxy systems, silicone polyesters and now various forms of acrylic films (polymers). The latter is the popular "sheet" bonded to the metal prior to fabricating.

3.2 Observations

The owners of thin-walled metal structures should regularly observe the appearance and the condition of their structure to determine when deterioration begins. The earliest and most commonly detectable sign of coating breakdown is a process known as chalking. Chalking is primarily caused by ultraviolet breakdown and appears as a thin layer of powder-like pigment on the structure's exterior surface. At the appearance of chalking or any sign of blistering or pitting, the owner should secure an inspection by a qualified professional.

4. INSPECTION

4.1 By Whom

An inspection of the thin-walled building should be done by a qualified Architect or Engineer, that is familiar with coatings and their application.

4.2 General Procedure

The inspection should cover all parts of the thin-walled structure, with particular emphasis on exterior wall condition. The inspector should note all defects, the assumed cause, and the extent of the problem.

4.3 Report to Owner

The inspector should give the owner a detailed report on each part of the structure and the assumed reason for the defects or breakdown in the coating system.

4.4 Responsibility of Owner

The type of factory coating should be made available to the inspector to assure compatibility of paint systems. The inspector should also be given data on the thickness of the metal panels, so he can properly specify the method of surface preparation compatible to the metal.

5. SELECTION OF RECOATING MATERIAL

5.1 Review

Other than galvanized, aluminized and galvalume systems, there are three other standard organic finishes used by the metal building industry. Proper selection of a new coating system is the first and most important step in assuring a successful re-painting project. Along with compatibility, the other important thing to address is the environment in which the building is located, and the specific atmospheric elements that may attack the new system. A brief overview of paints compatible to factory coatings follows:

5.1.1 Aged Galvanized Surfaces

The most compatible material for this type of surface is an oil-cementitious, prime coat system. These primers have excellent wetting ability and low surface tension that gives good penetration. Longer oil lengths should be selected because of increased flexibility and durability. This primer would be top-coated with an acrylic.

Another acceptable retrofit system is the use of urethane primers, that are aluminum-pigmented, followed by an acrylic polyurethane enamel.

5.1.2 Factory Applied Acrylics

After proper preparation it is recommended that moisture cured urethane primers be used, followed by an intermediate epoxy-polyamide coating and then a final coating of acrylic polyurethane enamel.

5.1.3 Factory Applied Polyester

There are two common systems that will adapt satisfactorily to older polyesters. One is a moisture cured urethane primer followed by an intermediate epoxy-polamide coating and then a final coating of acrylic polyurethane enamel. A second and excellent system is an epoxy-polyamide primer followed by an aliphatic polyester polyurethane enamel.

5.2 Material Capabilities

In selecting the proper material from the above group, it is essential that the environment be considered in order to give longer life to the recoating system. The specifier must have a good knowledge of the generic types of primers and topcoats in order to match the durability of the system to the known or anticipated environment.

5.2.1 Primer Selection

The oil cementitious primer compatible with aged galvanized surfaces affords excellent wetting, and penetrating ability. It is excellent for fresh or salt water environments, but limited in life in environment containing inorganic acids, alkalies, gases and solvents. The moisture cured urethane primers are more protective in the latter environments, except for sulphur gases. Both primers should be followed by a compatible topcoat.

5.2.2 Intermediate and Topcoat Selection

In the enamel type line, excellent protection against severe environments can be obtained through the use of acrylic urethanes. These two-component urethanes have high initial gloss and excellent gloss retention. However, this material is subject to deterioration when exposed to chlorine gas and some refinery crudes.

Except for older acrylic surfaces, the new polymide epoxies are ideal for intermediate coats when harsh environments prevail. One thing that makes this material ideal for metal buildings is its ability to bond well and still be flexible enough to resist dimensional temperature changes.

A really superior final coat, either glossy or semi-glossy can be obtained through the use of polyester polyurethane enamel coatings. This two-part material of ethylene glycol, ethers and ketones in the first part, is mixed 2:1 with high solids alphatic polyisoeynate, acetates and solvents. This coating is highly resistant to wet conditions, corrosive fumes and chemical contact. This is also an ideal topcoat for restored, primed galvanized structures.

6. SURFACE PREPARATION

6.1 The Key to Success

The importance of surface preparation is fundamental to all recoating applications, because one of the major contributing factors of coating failures is poor surface preparation. The applied coating is no better than the surface on which it is applied. For recoating of metal structures, all dirt, grease, rust and any non or poorly adhering factory coats must be removed, followed immediately by one of the above recommended primers. The specifier is certainly responsibile for detailing the surface preparation in his specifications, and assuring the owner that the specifications are followed.

6.2 Preparation Methods

Preparation methods done prior to recoating of metal buildings vary with the selected coating, the environment and the type and condition of the original material. Several methods have been established by the "Steel Structures Painting Manual, Vol. 2." However, it has been found that there are four basic methods that are best suited for use on thin-walled metal structures.

6.2.1 Solvent Cleaning

Solvent cleaning is classified as SSPC-SP1 and specifies the removal of all dirt, oil, grease and foreign matter, as well as chalking (powdery pigment) by the application of commercial solvents and cleaners. Although wiping is mentioned in the specification, power wash or steam cleaning are the most efficient and complete methods.

6.2.2 Hand Tool Cleaning and Power Tool Cleaning

Hand tool cleaning (SSPC-SP2) and power tool cleaning (SSPC-SP3) are exactly what the term implies and usually follow a good solvent cleaning. However, these methods are not totally adequate for surface preparation where exposure will be moderate to severe, and they do not completely prepare the surface for recoating of acrylics, polyesters or siliconized polyesters.

6.2.3 Commercial Blast Cleaning

The commercial blast cleaning method, (SSPC-SP6) requires the removal of at least two-thirds of all original paint, all visible rust and other foreign matters. This is done by use of compressed air nozzle blasting at a 520 kPa (75 psi) pressure. This method must be used where existing paint has deteriorated and is usually adequate for most surfaces.

6.2.4 Brush-Off Blast Cleaning

The brush-off blast cleaning process (SSPC-SP7) calls for the removal of loose rust, paint and foreign matter. This method, which is always preceeded by solvent cleaning is found to be best for extremely thin metal walls in ranges from 24 to 26 gauge, but is not good in areas of severe environments.

Because the blast cleaning methods are the most popular, I would like to note some specific areas to observe. For galvanized surfaces, it is extremely important to check all seams to insure that rust has been removed and to replace any rusted bolts or clips, cleaning the openings, as good as possible. One should apply the selected prime coating immediately after cleaning and brushing. For old acrylic or polyester coatings, all loose, chalked or cracked areas must be removed, and any painted areas remaining should be clean and tightly bonded to the metal. It will sometimes be necessary to follow guidelines for "Commercial" and "Brush-off" methods on a single structure. "Brush-off" is usually adequate when facia flashing overlaps deep ribbed panels.

Where the sheet steel is badly deteriorated and pitted, blasting should not be severe. Some areas will require the care of hand tool cleaning. These variations should be noted in the Engineer's inspection and stated specifically in the specifications.

6.4 Abrasives

The selection of abrasive material is critical because it is a prime factor in creating a good "surface profile" that permits adhesion but does not exhibit exposed peaks. The abrasive material must be kept clean and free of oil and moisture. This is necessary to secure a sharp angular profile that affords a good bonding surface. For recoating, the sharp, hard silica sand abrasives are recommended, as they are not generally recycled, and the material is clean and dry.

7. APPLICATION

7.1 Specifications

In establishing proper application procedures the specifier must consider a number of important and related factors to secure the best finish on a properly cleaned and prepared surface.

7.1.1 Brush

In general, most paint coatings can be applied by brush, roller or spray equipment. However, it is considered better painting practice to apply the first coat of paint to any surface by brush. Primers or pre-treatments on metal should be applied by brush or brush and roller when wind conditions dictate. Under certain conditions, wind velocity above 24 km/h (15 mph) can cause material loss, inadequate film build, overspray and dry spray where air sprayers are used. Generally, greater care in application must be exercised to insure proper spread and application to all depressed areas and seams. This requirement should be foreseen by the specifier, and noted in the specifications.

7.1.2 Air Spray

Most paint manufacturers will note the specifics for spray applications (air or airless). However, the guidelines should be noted in the specifications and wind limitations set forth in a firm manner. Where spray application is used, the Engineer should definitely check the wet and dry film thickness at regular intervals and control the work under windy conditions.

7.2 Product Preparation

Most high solid coatings will settle in storage. Proper mixing is necessary to redistribute the solids before using. Thinning is required in some instances, but this should only be done if the manufacturer recommendes thinning. It is also important to use only thinners recommended by the coating manufacturer.

In the case of epoxies or other two-component materials, it must be remembered that such materials have a limited pot life once the two components have been mixed together. It is important that the specifier know the pot life of such materials, and that he does not allow the mix of more material than can be used in the prescribed time. Applying materials that have been allowed to sit around for more than the allotted pot life will result in poor adhesion and/or complete failure.

7.3 Environmental Conditions

Due to the large surface area of most metal buildings, and because the exterior surfaces are most often recoated, the environment is very important. All coating manufacturers furnish data on temperature and humidity parameters. A minimum and maximum is usually given and for most primers is 4°C (40°F) to 49° C (120°F). Finish coatings of epoxy and acrylic polyurathene are the same. However, most epoxy base coatings have a lower limit of 10°C (50°F).

7.4 Test Patch

Prior to coating a structure, it is highly recommended that a test patch of primer and then intermediate or final coating be applied. With this test patch, adhesion can be checked to assure compatibility of all components.

7.5 Coating Thickness

Each type of coating manufactured has a recommended wet and dry mill thickness that should be followed. This film thickness is expressed in mils. The inherent resistance characteristic of any coating to various environmental influences determine the total mil thickness that should be achieved with a certain coating system.

7.5.1 Paint Solids

The non-volatile content of a coating is the solids portion, which is that part of the whole coating which will remain on the surface, once the solvents evaporate. In attempting to obtain a certain coating thickness on a structure, it is most desirable to achieve this with a multiple-coat system. Hence the primer, the intermediate coat and the finish coat.

8. CONCLUSION

In concluding this paper, the author wishes to express appreciation for technical assistance from the TNEMEC Company and call to the attention of owners and coating specifiers the extreme importance of selecting coatings compatible to the building surface material, making sure the surface is properly prepared and the environmental compatible product is applied with care and thorough attention to details.

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