Hot Dip Galvanizing Data Sheet GA

4.3 Hot Dip Galvanizing Plus Organic Coating = Duplex System

1. Definition

Hot dip galvanizing is the process in which a coating of zinc and zinc iron alloys is metallurgically bonded to a steel or iron substrate by dipping it into molten zinc.
A coating, in the general sense, is a generic term for one or more layers of interconnected coating materials on a base.
A duplex system is the combination of two independent corrosion protection systems. Ideally, they should complement each other as well.

2. Types of use.

Duplex systems consisting of an organic coating on top of a hot dip galvanized coating are used in many areas where corrosion protection of the steel is vital. Examples are in the construction industry, street furniture and in the chemical and power industries (fig. 3). The advantages of a duplex system are:

Long lasting protection.
The lifetime of the protection afforded by a duplex system is usually significantly longer than just the sum of the lifetimes of the two individual systems. The two have synergistic effects, which means that the two coatings combine for mutual benefit. Put mathematically, $L_T = k(L_{Zn} + L_P)$
Where L_T = Total lifetime
L_{Zn} = Lifetime of galvanized coating alone
L_P = Lifetime of paint coating alone
k = A constant
The increase in lifetime caused by the synergy (the constant k) is usually within the range 1.2 to 2.5, depending upon the system.

Aesthetic reasons.
The galvanized coating on its own has a silvery or grey appearance. With duplex coatings it is possible to take advantage of the huge range of colours available in paint.

Visual significance or camouflage.
Colour coding is often needed to serve as a warning or for identification purposes. In other circumstances a camouflage effect may be necessary. Either way, a duplex system will give the required result whilst retaining the excellent corrosion protection of galvanizing.
There are very few limitations to the use of duplex systems (fig. 2). In many cases it is best when applied in a factory under controlled conditions by a specialist operator. This avoids the possibility of work being carried out on site where variations in humidity and temperature can cause problems with paint application. Factory application also avoids any undesirable exposure to solvents on site and release of solvents to atmosphere.

3. Method of protection.

The way in which the duplex system works depends upon the reciprocal protection of the two components. The hot dip galvanized coating is protected from atmospheric and chemical attack by the organic coating covering it. The galvanizing remains underneath in a condition near to the original and therefore lasts longer.
Any local damage to the organic coating will not have serious consequences for the steelwork because of the toughness and cohesiveness of the galvanizing. If damage is severe and breaks through both coatings, rusting will be localised and will be prevented by the zinc from spreading underneath the paint coat.
Organic coatings eventually fail through a series of microcracks that allow rainwater to permeate through. If the paint is directly on steel, rust products form which expand the cracks. More water is let in and more rust is formed until the coating simply flakes off. However, when microcracks appear in paint on top of galvanizing a different mechanism applies. Moisture which permeates the paint meets zinc. Corrosion products are formed which fill up the microcracks and to some extent seal them off. In this way the organic coating lasts longer (fig. 1).
In the hot dip galvanizing process, molten zinc covers the entire surface of the steel, including hollows, depressions, corners and edges so that there are no bare spots. Any areas not covered by a subsequent organic coating process will still be protected by zinc.
The resulting synergy is advantageous to both systems.

4. Standards.

In the UK, British Standard BS 5493: 1977 "Protective coating of iron and steel structures against corrosion" gives useful guidance on the different types of protection systems available. The relevant factors affecting the choice of system are reviewed and cross references are made to individual system standards to enable thorough detailed specifications to be formulated.
European standards are in preparation. They will give further up-to-date advice for metallic and duplex system users. Reference should be made to individual system specifications such as that for hot dip galvanizing (pr EN 1029) and the developing guidance document on the use of metallic coatings for the protection against corrosion of iron and steel in structures (pr EN number to be announced shortly). This guide includes graphs and tables showing the expected lifetime to first maintenance for a number of metallic based systems operating in a range of different corrosion environments. This allows the specifier to make a quick and informed choice of the system to be used.

5. Surface preparation.

The essential prerequisite for a successful duplex system is correct preparation of the galvanized surface. And the type of preparation will depend to some extent upon the age and condition of the galvanizing.

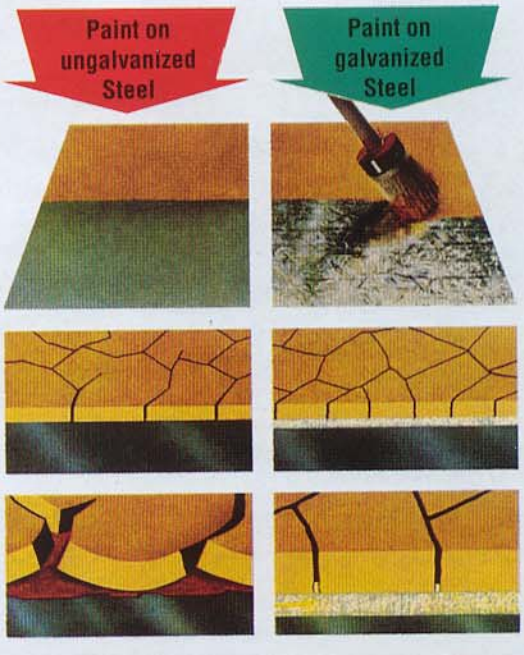

Fig. 1: Comparison of protection afforded by duplex coating and a conventional system.

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Newly galvanized (unweathered) material.

Upon its withdrawal from the galvanizing bath, the coating will start to react with oxygen in the atmosphere and will be covered with very thin layers of oxides. These are only a few nanometres (nm) thick. If there are no other surface contaminants such as chlorides from the flux or condensation a coating can, in theory, be applied immediately without further surface preparation.

In practice, however, galvanizing and painting seldom take place on the same site and so the interval between the two is much longer. In this case the galvanizing will require some surface preparation such as:

- washing or chemical degreasing followed by a mordant wash (T Wash).
- sweep blasting (very mild, low pressure blasting of the surface).

Old galvanizing

In the case of older, weathered, galvanizing and depending upon the time spent exposed to wind and rain and the position of the galvanizing, tough stable corrosion products may have formed on the surface. In theory, coatings can be applied directly to a fully weathered galvanized surface but in practice one of the two processes mentioned above should be used. In some circumstances weathered galvanizing may need more intensive treatment than unweathered due to surface contamination.

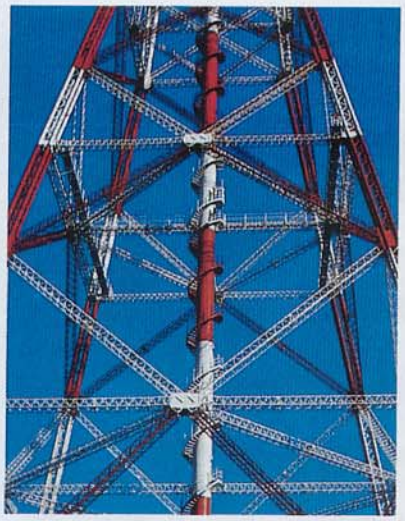

Fig. 2: Duplex protected electricity pylons in Stade on the lower Elbe (the highest in Germany at 227m in height).

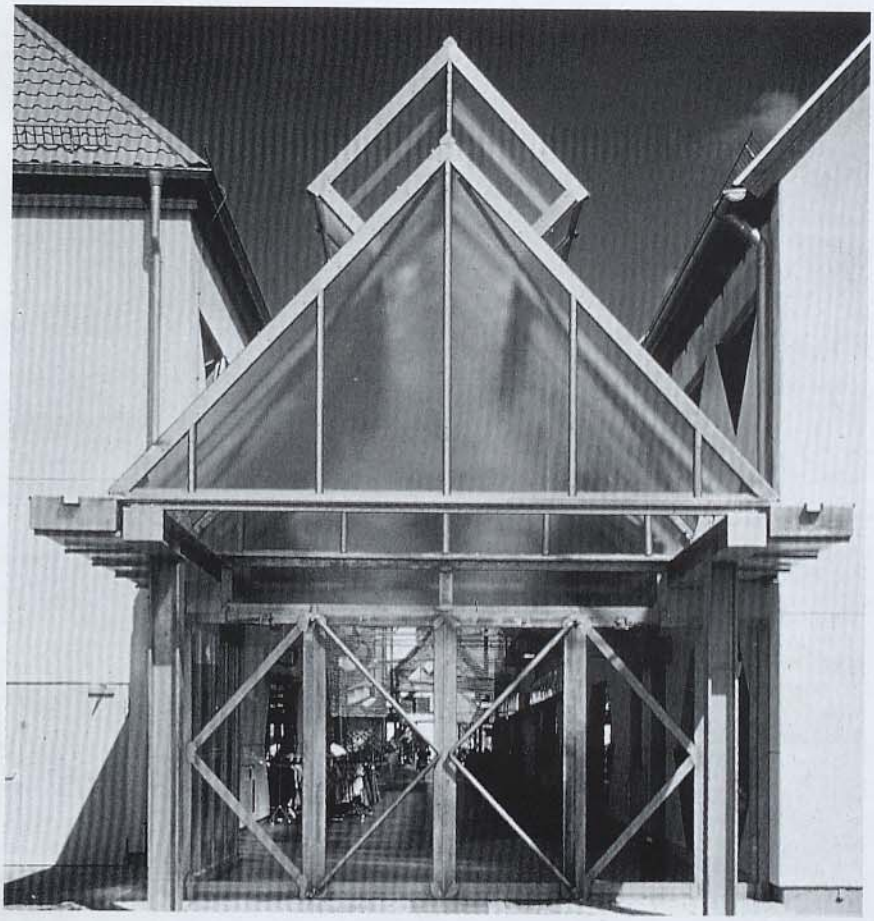

Fig. 3: Duplex system on the steel structure of a shopping centre.

6. Coating materials.

The types of coating materials used will have a considerable effect upon the properties of a duplex system, particularly with respect to the adhesion of the system.

Research carried out by Galvanizers Association in conjunction with paint makers W J Leigh and BNF Fulmer Research has shown that a wide range of paint systems can be successfully adapted for use on galvanized steel. This allows a considerable choice in organic coating finish.

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