Hot Dipped Galvanised Steel Lighting Column Root Protection Systems

'Protecting the vulnerable root'

Contents

1. Scope

This document is intended to provide up to date guidance on the root protection of galvanised steel lighting columns in the light of developments in available paint systems.

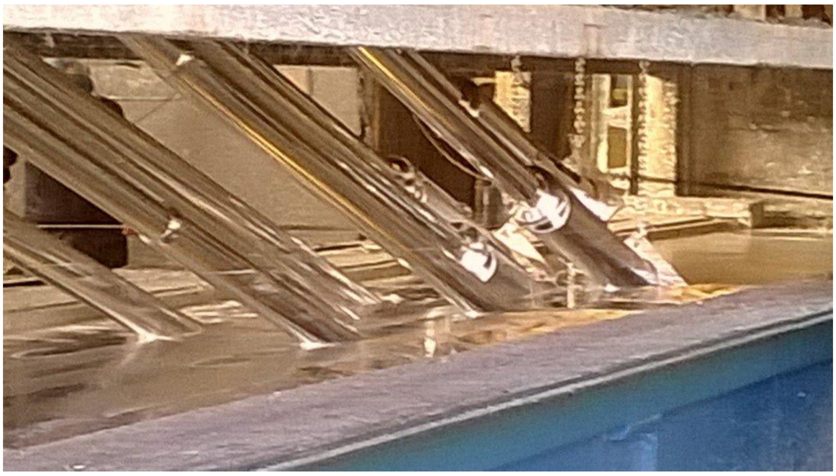
Whilst most root protection is by factory applied paint or bitumen systems, thermoplastic coatings are also available and have been in use for some time. Columns manufactured from other materials including aluminium may also require protection, but the methods used are not included within the scope of this document.

2. Introduction

Over the years changes have taken place to the design and manufacture of steel lighting columns. Improvements were made to known problem areas for trapping and retaining moisture, particularly around the swage and bracket fixing areas, which contributed to corrosion cells forming.

Some 40 years ago steel lighting columns would probably have been primed in a variety of single pack materials and usually finished by painting on site with single pack paint, usually alkyd type finishes.

Additional root protection would have come from the application of a bitumen solution. However lighting columns were manufactured from the limited range of structural sections available, and this would generally result in the column having additional steel to that required by design and as such a high residual strength.



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The early 70's saw the introduction of the metal spray system which was applied to the external surfaces of steel lighting columns.

This method of application required the surface to be cleaned by mechanical abrasion, which was a major step forward in surface preparation. While the aluminium or zinc used in the metal spray process would have improved overall protection externally, it did not address the internal corrosion concerns.

The practice was to apply a bitumen solution to the internal surface of the column and externally to the root as additional protection.

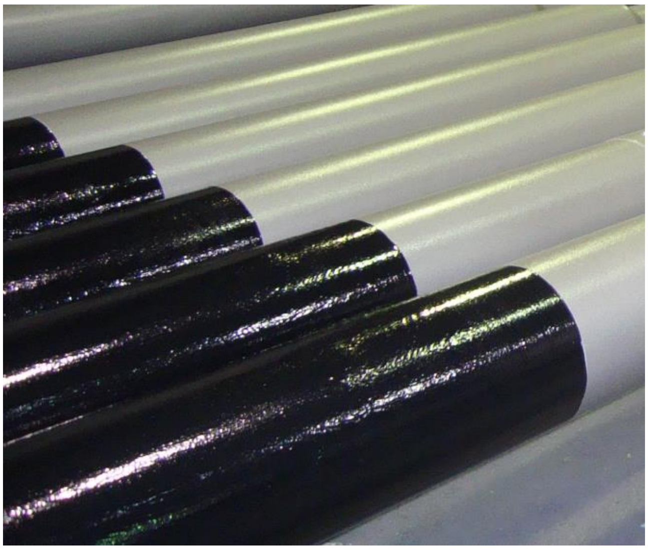
In the early 1980's, with the introduction of BS 5649 (currently BS EN 40), cold-formed sections were being offered with a wider range of thicknesses. This meant that columns were designed to the limits set by the standards and giving no sacrificial steel thickness above the design requirement. Furthermore giving importance to corrosion prevention than columns designed to BS 1840.

However, the previous standard root protection did not appear to be 'high on the agenda' in the discussions that took place on the protection of galvanised lighting columns.

By the early 90's the Highways England Series 1900 protection of steelwork against Corrosion, was being readily used and made some significant changes to the way galvanised lighting columns were to be protected. In particular, the introduction of Epoxy Primers and Pitch Epoxy or Coal Tar Free Epoxy as the additional root treatment was designed to offer improved performance and durability extending the life of galvanised and metal-sprayed lighting columns.

N.B.: *See current revisions of Highways England G1, G2a, G2b for further reading.*

3. Paint Systems



Bitumen

This type of root treatment has been around for a very long time and is predominantly used on traffic poles and signposts. There is a view that it offers very little in the way of root protection especially in aggressive ground conditions. Should an option be required then a Vinyl Copolymer MIO/ Sheen finish would be a more suitable alternative. However, bitumen protection should not be ruled out completely as it has performed well in many areas.

In the current revisions to the Highways England Specification for Highway Works Series 1900, the Thixotropic Bitumen Item 141 has been withdrawn and no longer features in the Highways England paint systems.

Vinyl Copolymer

Customer requirements for single pack high performance be-spoke paint specifications have seen the introduction of Vinyl Copolymer resin type paint systems. Vinyl co-polymer root treatments allow the incorporation of micaceous iron oxide (MIO) or glass reinforcement, designed to offer excellent barrier protection, durability and performance.

Moisture Cured Urethane

This type of single pack high build finish can also be used for the protection of column roots. It will provide an abrasion resistance finish and offers low temperature curing properties.

Highways England G1, G2a, G2b

In the latest revisions to Highways England Series 1900, Pitch Epoxy Item 150, Coal Tar Free Epoxy Item 151 have been withdrawn and no longer features in the Highways England paint systems.

The root treatment now being specified in G1, G2a and G2b paint systems comprises of multiple coats of 2-pack epoxy MIO (final colour black).

These changes are designed to simplify the painting process, while at the same time offering much improved performance in the root section and up to 250mm above ground level.

N.B.: *Further reading and updates to 1900 Series painting documents can be found at:*

- Manual of Contract Documents for Highway Works Series NG 1900 Protection of Steelwork Against Corrosion (Amendment – August 2014)
  http://dft.gov.uk/ha/standards/mchw/vol1/index.htm

- Manual of Contract Documents for Highway Works Volume 2 Notes for Guidance on the Specification for Highway Works Series NG1800 Structural Steelwork
  http://dft.gov.uk/ha/standards/mchw/vol2/index.htm

Epoxy MIO/glass reinforced epoxy

With the introduction of the latest epoxy resins and laminar filler pigmentations, improved lighting column root protection is now available. 2-pack extended cure epoxy MIO (Item 121) offers excellent adhesion and barrier protection.

Additional barrier protection can also be provided using a glass reinforced epoxy, which will provide a hard, durable coating designed to withstand weed control chemicals, soil contamination and dog urine.

4. Thermoplastic coatings

Acid modified polyolefin coatings are a range of thermoplastics that have been available for over 25 years. Lighting columns, pipes, fencing and street furniture are the main applications providing an effective and long lasting solution to provide additional protection to galvanised substrates. Polyolefin coating is particularly effective on the vulnerable root section offering excellent barrier properties and is acknowledged to be equivalent to the high end multi-coat paint system now available.

5. Root back filling after installation

Whichever root protection system is adopted it should be recognised that careless and inappropriate back filling can damage the system and reduce its effectiveness.

Course, irregular aggregates in the backfill, be it natural or concrete, should be avoided.

6. Conclusion

When choosing a root protection system the specifier should consider the need to prevent corrosion, resist mechanical abrasion and the attack from electrolytes in the ground water that can cause the material of the root to be conducted onto surrounding objects by electrolytic action, these factors may vary from site-to-site.

By choosing the correct root treatment, applied in accordance with the manufacturer's product data sheets/paint specification, the expected life of the galvanised lighting columns can be achieved.

1. For paint systems a root protection system comprising :

   - 2-pack extended cure epoxy MIO Item 121 applied at 100 microns dry film thickness

     and

   - 2-pack glass reinforced epoxy applied at 200 microns dry film thickness, giving a total dry film thickness of 300 microns offering a superior root protection.

   This type of root treatment can be combined with a high performance paint system for the above ground sections of galvanised steel lighting columns by using one of the following systems:

   - 2-pack polysiloxane
   - 2-pack urethane
   - 2-pack acrylic

   This offers customers a superior paint system with extended life than many of the out dated specifications still in circulation today.

2. If Thermoplastic option preferred,

   There is also the option of an acid modified polyolefin root protection comprising of the application of a thermoplastic powder by dipping, electrostatic or flock spraying to achieve an external build between 300-800 microns, and internal thickness >175 microns if required.

   This coating can be extended to the whole surface of the column giving excellent overall performance; offering a better solution to many outdated products still in circulation.

7. Bibliography

- British Standard BS 1840: Specification for Steel Columns for Street Lighting
- British Standard BS 5649: Lighting columns - Specification for materials and welding requirements
- BS EN 40: Lighting Columns
- Highways England Series 1900, Protection of Steelwork against Corrosion
- Highways England G1, G2a and G2b

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Appendix 1

Galvanizing Association – Hot Dipped Galvanizing Data Sheet

Hot Dip Galvanizing Data Sheet GA

3.10 BS EN ISO 14713 – A guide to the corrosion perfomance of hot dip galvanized steel

BS EN ISO 14713 ("Protection against Corrosion of Iron & Steel in Structures – Zinc and Aluminium Coatings – Guidelines") provides information on materials that can be galvanized, design for galvanizing and coating performance that assists the specification of protective coatings for iron and steel. This Data Sheet summarises the information on corrosion performance presented in the new European standard.

General considerations

The resistance of galvanized coatings to atmospheric corrosion depends on protective surface films that form on the zinc coating surface. These usually consist of zinc oxide or zinc carbonate; where zinc interacts with oxygen and carbon dioxide present in the atmosphere.

The presence of airborne contaminants has an effect on the nature of these protective films and so influences the corrosion rate of zinc.

	Corrosivity Category	Average Annual Zinc Corrosion Rate (µm/year)
C 1	Interior: dry	<0,1
C 2	Interior: occasional condensation Exterior: rural	0,1 to 0,7
C 3	Interior: high humidity, some air pollution Exterior: urban inland or mild coastal	0,7 to 2
C 4	Interior: swimming pools, chemical plants, etc Exterior: industrial inland or urban coastal	2 to 4
C 5	Exterior: industrial with high humidity or high salinity coastal	4 to 8

Table 1. Zinc corrosion rates in different environments (Source: BS EN ISO 14713)

The most important contaminant for zinc is sulphur dioxide (SO_2) and it is the presence of SO_2 that largely controls the atmospheric corrosion of zinc. Amongst other considerations are relative humidity and, in marine environments, salt concentration. Relative humidity governs the absorption of SO_2 by the zinc surface and consequently the reaction between zinc and SO_2. Salt and nitrogen oxides have a less marked effect. Other important points to remember are that:

- Rates are generally linear for a given environment. This allows predictions of ultimate life to be made on the basis of interim assessments of coating thickness.
- Rates increase with duration and frequency of wetness.
- Rates due to contact with chemicals require special consideration. A wide range of chemicals are compatible with zinc coatings. Strong acids and strong alkalis are not compatible.
- Rates in immersed conditions require special consideration. Corrosion rates in sea water in temperate regions can be 10 µm/year to 15 µm/year. Tropical sea water, which is usually at higher temperatures, may cause higher corrosion rates.

Atmospheric corrosion - predicting coating life

Different environments are largely classified according to prevailing levels of SO_2. See Table 1 and Fig. 2.

Identifying the correct corrosivity category to allocate to a proposed structure can be difficult and often subjective. Experience with structures (case histories) can be helpful in this regard, as can the information from various test sites operated by the National Materials Exposure Programme (NMEP). The NMEP results confirm the relationship between SO_2 levels and zinc corrosion rate. The corrosion rates for zinc measured during the period 1988-90 are shown in Table 2:

For structural steelwork, where coating thickness inevitably exceeds the minimum requirements of the standard, the estimated lives will be higher than those indicated in Table 2.

NMEP Site	Average Annual SO_2 level (µg/m³)	Average Zinc Loss (µm/year)	Estimated life of 85µm coating (years)
Birmingham	37.6	2.29	37
Cardiff	21.7	2.08	41
Ashby de la Zouch	17.8	1.73	49
London	15.2	1.65	52
Caerphilly	7.3	1.43	59
Wells	6.2	1.25	68
Lough Navar	1.7	1.04	82

Table 2. SO_2 levels and zinc corrosion rates at 7 U.K. sites, 1988-90.

It is important to note that the corrosion rates for areas often described as "industrial" or "urban" are significantly lower than those quoted in other literature. In particular, BS 5493 (1977) 'Code of Practice for Protection of Iron and Steel Against Corrosion', provides corrosion data for zinc which does not reflect the recent and ongoing reductions in airborne SO_2 levels.

These reductions in SO_2 levels have been illustrated by comparing the atmospheric corrosivity maps produced by Ministry of Agriculture, Fisheries and Food (MAFF) in 1982, 1986 and 1992. The maps identify zinc corrosion rates for each 10km square of the UK. Comparison of the three maps clearly shows that the propor-

3.10 BS EN ISO 14713 – A guide to the corrosion perfomance of hot dip galvanized steel

tion of the country exhibiting historically higher zinc corrosion rates had steadily decreased between 1982 and 1992. The maps are published in Galvanizers Association's *Engineers and Architects' Guide to Hot Dip Galvanizing*. A new map is currently under preparation by the Association and will provide corrosion rates for zinc for the UK and Ireland for the period 1998 – 2000. The 2000 results can be expected to further demonstrate the increasing life of galvanized steel in many areas of the UK and Ireland.

Several studies in mainland Europe have correlated these reductions in the zinc corrosion rate with decreases in atmospheric SO_2 levels. An example from Stockholm is shown in Figure 1. Similar effects can be expected for urban areas in the UK, given that SO_2 levels have decreased in major cities.

In particular, urban locations which, in the past, may have been considered aggressive for zinc will yield significantly enhanced lives for galvanized coatings. In more remote locations these downward trends in SO_2 levels are not so pronounced and the (already low) corrosion rates for zinc would not be anticipated to be further reduced to any significant extent.

It is clear that these reductions in atmospheric corrosion rate significantly contribute to the improved life of hot dip galvanized coatings over recent years. Care must therefore be taken to utilise recent information concerning zinc corrosion rates in any estimations of coating life for exterior exposed structures. BS EN ISO 14713 gives an excellent guide to atmospheric corrosion performance and is based on more recent data.

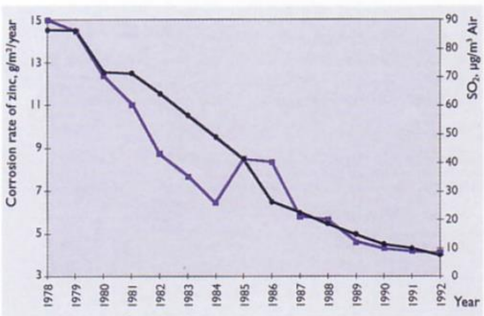

Fig. 1. Reduction in SO_2 levels in Stockholm since 1978 and accompanying decease in corrosion rate of zinc.

Corrosion in soil

BS EN ISO 14713 outlines the considerations when evaluating the performance of galvanized coatings in soils. Galvanized coatings have given excellent performance in, for example, underground pipework and reinforced earth structures. Usually it is best to seek specific guidance from Galvanizers Association on performance in soils, but the standard outlines the essential factors as follows:

- Coating life is dependent on the nature of the soil mineral content, organic components, water content and oxygen content.
- Coating life will be longest in lime-containing and sandy soils (provided they are free of chlorides).
- Coating life will be a little shorter in clay soils.
- Coating life in bog or peat soils will depend on their acidity.

Corrosion cells that may be set up at the soil/air or soil/groundwater interface may reduce coating life. These factors also require specialist consideration.

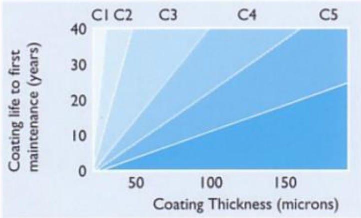

Fig. 2. Estimated lives to first maintenance of galvanized coatings in different categories of environment. (Source: BS EN ISO 14713, for description of corrosivity categories: See Table 1).

Corrosion in water

Performance of galvanized coatings in water is also outlined in BS EN ISO 14713. Again, this is a complex area of corrosion science and specialist guidance may be required in addition to that laid out in the standard. Nevertheless, the main aspects are:

- Type of water has a major influence on selection of metal coatings for protection of iron/steel in water.
- Corrosion of galvanized coatings is mainly determined by the hardness/composition of the water.
- Other factors affecting corrosion rates are temperature, flow rate, agitation and oxygen availability.

Coating lives are generally longest in cold scale-forming waters and shortest in non scale-forming waters. Galvanized coatings are not suitable for use in hot, non scale-forming waters. Contact with condensate between 55 °C and 85 °C should be avoided.

Corrosion performance in sea waters is best established by reference to experiences with similar structures (case histories). Such information is available from Galvanizers Association.

Exceptional exposures

Contamination from industrial processes and other site-specific conditions can affect coating life. A wide range of chemicals are compatible with galvanized coatings but exposure to acids should be avoided. Detailed guidance on contact with specific chemicals is not contained in BS EN ISO 14713 but is available from Galvanizers Association.

These Data Sheets are intended for guidance only. The standard documents themselves should be consulted when preparing specifications.

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