SMD®
Structural Floor and Roof Solutions

Technical Guidance Sheet Durability of Steel Deck Composite Floors

Introduction

SMD (Structural Metal Decks Ltd), have supplied and installed millions of square metres of steel decking, across all sectors, from office/mixed-use and its typically non-aggressive environment to Leisure, where a considerably more aggressive environment may exist (i.e. adjacent Swimming Pool areas).

A key consideration when specifying a composite steel deck floor is durability and more specifically, the life to first maintenance (LTFM).

This document gives some guidance on the subject. It does not provide a definitive answer, as one does not exist due to the numerous factors involved (i.e. corrosivity of environment, project location, ventilation etc.).

SMD Profiles – Standard Coating

Unless otherwise specified, SMD profiles are manufactured from hot-dip galvanised steel strip designated: BS EN 10346: S350GD+Z275-N-A-C (S450GD+Z275-N-A-C for 450N/mm² grade products).

These products have a coating mass of 275g/m² which equates to a thickness of approximately 0.02mm (20µm) per face.

Hot-Dip Galvanised Coating

Although the galvanising provides a protective coating, it does weather, albeit at approximately one tenth of the rate of steel (depending upon the prevailing conditions and thickness of coating).

Factors which may affect the speed at which the galvanising deteriorates and subsequently exposes the steel substrate to produce rust as a result include:

- Length of time the installed deck is exposed to the elements before the building envelope is complete
- Localised damage to the deck during installation (deck sheets are typically dragged across the supporting structure which could scuff the finish and remove some of the coating)

- Failure to provide adequate ventilation when allowing buildings to dry out leading to condensation on the deck soffit
- High humidity levels/poor ventilation when the building is in use
- Presence of chemical agents
- Presence of other liquid based materials that are detrimental to the zinc coating
- Airborne pollutants

PLEASE NOTE – Both the 275g/m² and 310g/m2 coatings options for SMD products are adequate for the relatively short period of exposure between rolling of the deck profile and enclosure within the building fabric.

Corrosivity Category

BS EN ISO 9223 documents corrosivity categories C1 to CX; with C1 for Interior: dry (low corrosivity) to CX Extreme Humidity (high corrosivity).

There is a wealth of information on the subject. The Galvanizers Association (2011) and Galvanizers Association of Australia (2012) providing useful guidance on Corrosion Categories, Typical Environments and Corrosion Rates.

For exterior exposed structures, the geographical location (both country and region) will influence the corrosion category applicable, see Fig.1 below.

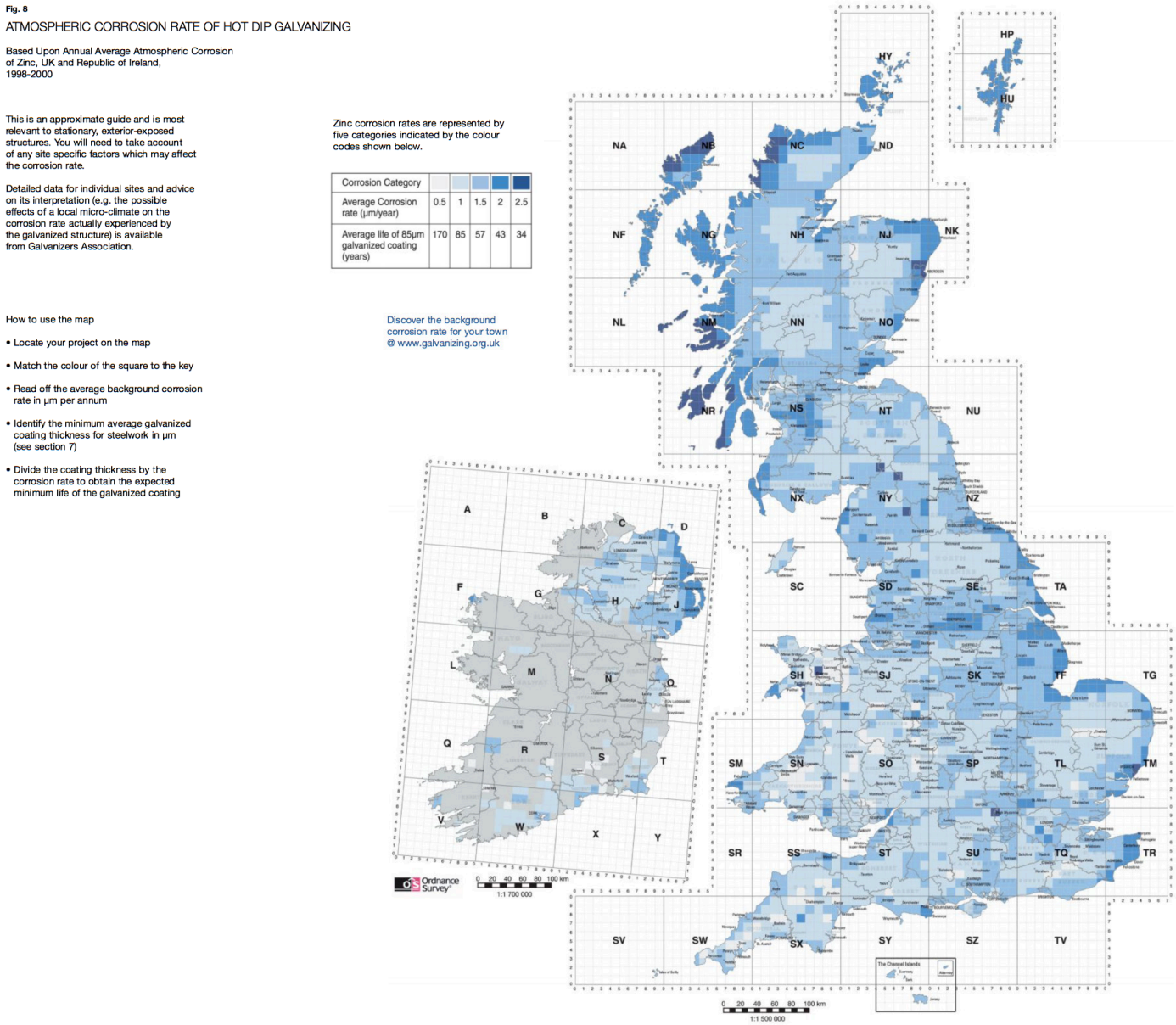

Fig.1 - 'Zinc Millenium Map' indicating regional corrosion categories (Galvanisers Association, 2011)

Corrosivity Category	Corrosivity	Indoor	Outdoor
C1	Very Low	Heated spaces with low relative humidity and insignificant pollution, e.g. offices, schools museums	Dry or cold zone, atmospheric environment with very low pollution and time of wetness, e.g. certain deserts, central arctic/Antarctica
C2	Low	Unheated spaces with varying temperature and relative humidity. Low frequency of condensation and low pollution, e.g. storage, sports hall	Temperature zone, atmospheric environments with low pollution (SO_2 < 5µg/m^3), e.g. rural areas, small towns Dry or cold zone, atmospheric environment with short time of wetness, e.g. deserts, subarctic areas
C3	Medium	Spaces with moderate frequency of condensation and moderate pollution from production process, e.g. food-processing plants, laundries, breweries, daries	Temperature zone, atmospheric environment with medium pollution (SO_2 : 5µg/m^3 to 30µg/m^3) or some effect of chlorides, e.g. urban areas, coastal areas with low deposition of chlorides Subtropical and tropical one, atmospheric with low pollution
C4	High	Spaces with high frequency of condensation and high pollution from production process, e.g. industrial processing plants, swimming pools	Temperature zone, atmospheric environment with high pollution (SO_2 : 30µg/m^3 to 90µg/m^3) or substantial effect of chlorides, e.g. urban areas, industrial areas, coastal areas without spray of salt water or, exposure to strong effect of de-icing salts Subtropical and tropical zone, atmospheric with medium pollution
C5	Very High	Spaces with very high frequency of condensation and/or with high pollution from production process, e.g. mines, caverns for industrial purposes, unventilated sheds in subtropical ad tropical zones	Temperate and subtropical zone, atmsphric environment with a very high pollution (SO_2 : 90µg/m^3 to 250µg/m^3) and/or significant effect of chlorides, e.g. industrial areas, coastal areas, sheltered positions on coastline
CX	Extreme	Spaces with almost permanent condensation or extensive periods of exposure to extreme humidity effects and/or with high pollution from production process, e.g. unventilated sheds in humid tropical zones with penetration of outdoor pollution including airborne chlorides and corrosion-stimulating matter	Subtropical and tropical zone (very high time of wetness), atmospheric environment with very high SO2 pollution (higher than 250µg/m^3) including accompanying and production factors and/or strong effect of chlorides, e.g. extreme industrial areas, coastal and offshore areas, occasional contact with salt spray

Table 1 - Typical corrosivity category environments according to IS09223 (ISO, 2012)

Life To First Maintenance

The expected Life To First maintenance is the estimated duration of effective protection of the steel by the metallic coating against perforation.

To determine the most accurate 'Life to First Maintenance', the environment in which the material will be located must be carefully assessed to determine which of these categories is applicable for the location in question.

Guidance values for Life to First Maintenance are show in Table 2 below.

	Life to First Maintenance	
Corrosivity Category	Standard Coating (275g/m2)	HD Coating (310g/m2)
C1	NA	NA
C2	> 28.5 years	> 90 years
C3	> 10 years	> 60 years
C4	> 5 years	> 40 years
C5	> 2.5 years	> 30 years

Table 2 Guidance of 'Life to First Maintenance' periods for coating options available for SMD products. (Galvanizers Association, 2011)

The periods for standard coating are calculated from corrosion rates given by Corus Strip Products (2007).

Further guidance on Life To First Maintenance can be found in SCI AD247, with Table 4.1 indicating predicted design life of up to 250 years for floors in warm frame applications, with no risk of water ingress or condensation and 100 years for suspended ground floors with over site membrane and low risk of water ingress; with some risk of condensation.

Aggressive Environments

Where the environment is deemed to be aggressive (i.e. Categories C3 - CX), additional corrosion protection measures should be considered by the responsible party, considering both aesthetics and structural implications.

SMD also offer a High Durability (HD) Coating which has the designation: BS EN 10346: S350GD+ZMA310. These products have a coating mass of 310g/m2 which equates to a thickness of approximately 0.025mm (25µm) per face.

Another option that may be considered for extending life to first maintenance is the addition of a suitable paint finish, see subsequent section.

Painting Steel Deck Soffits

One typical approach for both durability and often aesthetics, where deck soffit is exposed, is to apply some form of suitable finish, e.g. a compatible paint system. This provides a first line of defence which can be monitored and maintained without risk of jeopardising the structural integrity of the decking steel substrate acting as the tensile (sagging) reinforcement.

Where required, preparation for, and application of, paint systems to steel deck soffits is typically carried out on site following deck installation to minimise any damage to the coating. The galvanised coating is usually prepared with an etch primer to provide a suitable surface to which the paint will adhere; abrading or shot-blasting should not be used unless it can be guaranteed that the base steel will not be reduced in thickness (deck galvanising is approximately 20 microns on each face with a maximum bare steel thickness of 0.04mm less than the stated gauge, i.e. 0.86mm for a 0.9mm nominal gauge, 0.96mm for a 1.0mm nominal gauge, etc.).

Suppliers of paint systems for corrosion protection should be consulted regarding compatibility with galvanised steel and with respect to suitable specifications for the required design life in any potentially aggressive environments, including car parks.

There are a number of recommended paint suppliers who are members of BCSA, including:

- Sherwin-Williams Protective & Marine Coatings www.sherwin-williams.com
- International paint Ltd www.international-pc.com
- PPG Performance & Marine Coatings www.sigmacoatings.com

Further guidance on painting of galvanised coating can be found in Corus Strip Products UK (2007) and Galvanizers Association (2011).

Off-site paint application is an alternative option that can be facilitated by SMD, but is not recommended due to additional cost, extended lead-in periods, potential for damage during transit and/or installation and the likelihood of remedial work to the coating.

General Considerations / Conclusions

The general advice for use of steel decking is;

- For a typical dry internal location, no further corrosion protection is required.
- Steel deck composite slabs can be used in aggressive environments
- Corrosive environments may require additional protection (SMD HD coating or paint finish)

NOTE: The guidance outlined in this document is based on the most economical solution with the assumption that the decking is providing tensile reinforcement to the slab (design in accordance with BS5940-4 or Eurocode 4).

An alternative in aggressive environments where HD coating is not deemed appropriate is to utilise the steel decking as **permanent formwork only** with no contribution to the final slab design. In this scenario, the engineer will need to design the slab as a standard in-situ reinforced concrete slab with appropriate quantities of in-slab re-bar (this will typically result in greater quantities of reinforcement than when the decking is considered as tensile reinforcement). Since the deck is only required to carry load during the wet concrete construction stage, any deterioration of the galvanising and steel substrate over time does not affect the structural.

Bibliography

Corus Strip Products UK. (2007) Protected with strength - Solutions in Galvatite hot-dip galvanised steel. Available from: www.tatasteeleurope.com [Accessed 2nd March 2017].

Galvanizers Association. (2011) The Engineers and Architects Guide: Hot Dip Galvanizing. Available from: http://www.galvanizing.org.uk/literature/engineers_architects_guide/ [Accessed 2nd March 2017].

Galvanizers Association of Australia. (2012) Advisory Note GEN 12/2 - Atmospheric Corrosion Resistance of Hot Dip Galvanized Coatings. Available from: http://www.galvanizing.org.uk/literature/engineers_architects_guide/ [Accessed 2nd March 2017].

Steel Construction Institute. (2010). SCI Advisory Desk Note 247: Use of Composite Construction in an Aggresive Environment. New Steel Construction.

Tata Steel. (2012) Magizinc - For superior corrosion protection. Available from www.tatasteeleurope. com/.../Magizinc%20brochure%20Tata%20Steel.pdf [Accessed 2nd March 2017].

The Steel Construction Institute. (2009) P262 - Durability of Light Steel Framing in Residential Building. 2nd ed. London.

Further Guidance

In addition to the guidance and references provided in this document, further general guidance on corrosion protection of steel as a material can be found at the **BCSA steel construction information portal** (www.steelconstruction.info/Car_parks)