Guidance Note 8.06

The inspection of surface preparation and coating treatments

Scope

This Guidance Note describes the fundamental requirements relating to the inspection of surface preparation and coating treatments applied to steel bridges. It is intended to provide an appreciation of the need for total inspection throughout all of the stages associated with application of surface treatments for durability and appearance.

General

Most new steel highway bridges in the UK are protected in accordance with specifications contained in the Specification for Highway Works, 1900 Series [1] and most new railway bridges with specifications contained in Network Rail (NR) standard NR/L3/CIV/040: Specification for the use of protective coating systems [2]. These in turn rely on registered paint (SHW) or registered systems (NR) as part of quality assurance requirements.

In addition, painting contractors should be assessed to the National Highways Sector Scheme 19A for highway bridges [3]. This incorporates the individual applicator schemes like ICATS run by the Institute of Corrosion or the SSPC Train the Painter accredited scheme, for individual applicators which is also mandated for NR work.

Additional requirements for galvanizing and thermal metal spraying inspection are covered in GN 8.03 and GN 8.04.

Sometimes, client-designed specifications may be required instead, but whichever is to be followed, the basic principles for adequate surface preparation and the correct application of the protective coatings should be common.

It is important that, whatever the source of the specification, the required parameters/values should be clearly set out. In the instances where there are different methods available to check those parameters/values the frequency and method of checking and the interpretation should be made clear. Note this may also require checks on initial paint samples.

The employment of an appropriately experienced and/or qualified paint and coating inspector is essential to monitor for compliance with any specification, to record essential data and to advise where any non-conformances are found.

One recognised qualification scheme currently available is that certified by the Institute of Corrosion (ICorr Coating Inspection Scheme). This international scheme is available for the qualification and certification of industrial painting and coating inspectors and operates in accordance with BS EN ISO/IEC 17024 [4].

The inspector should also be qualified to the Thermal Spraying and Surface Engineering Association Inspector Scheme if the corrosion protection system incorporates thermally sprayed metal coatings (this is mandatory for NR work).

The inspector should have recourse to all of the equipment for inspection, testing and measuring the specified parameters plus the relevant standards for reference. Refer to BS EN ISO 12944-7 [5] for additional guidance.

The absence of a properly conducted inspection regime at the preparation and application stages can account for a significant number of the premature coating failures experienced in service. The costs associated with remedial treatment for coating systems that fail prematurely are well in excess of the costs for proper inspection.

Definition and requirements

The term ‘inspection’ is defined in BS EN 45020 [6] as the “evaluation for conformity by observing, testing or gauging the relevant characteristics”

Additionally, the evaluation for conformity is defined as "systematic examination of the extent to which a product, process or service fulfils the specified requirements".

Surface preparation

The performance of a coating is significantly influenced by a number of characteristics of the substrate including: its condition before treatment; its post-treatment state of cleanliness and surface profile and surface imperfections on welds and cut edges. All of these directly affect the adhesion of the protective coatings. See GN 8.01 for further guidance.

Surface preparation is the essential and most important first stage treatment of a substrate. There is little point in continuing with the application of the coating(s) if there is failure to achieve a satisfactory surface condition.

The importance of checking that surfaces are adequately cleaned both visually and chemically and profiled to receive the subsequent coating cannot be overstated.

Conditions at application of coating(s)

A basic requirement of all specifications is that the conditions of temperature and humidity are favourable for the application of the coating.

Normal practice is to measure the steel temperature with a contact thermometer and the humidity by using a whirling hygrometer or a combined dewpoint / electronic humidity meter. The dew point may be calculated from the readings obtained or directly output by the meter. It is usually specified that the steel temperature should be maintained at least 3°C above the dew point and the relative humidity is below 85%. Note this does not apply for moisture-cured paints where a minimum humidity is required, and the risk of condensation is not a concern.

Records of all environmental parameters should be kept along with dates, times and signature of the inspector. These records may be used as a basis for future maintenance programmes and are also essential to provide data in the event of premature coating failure.

Inspection and testing of metal coatings

The inspection of metal coatings is usually straightforward. A visual check is made on the condition of the surface and measurements are taken of the coating thickness.

For thermally sprayed coatings, the inspector should check that the coating thickness meets the specification, the surface is uniform in texture without coarse, lumpy or powdery deposits. Adhesion tests should be witnessed. Any damage to the coating should be noted and further checks made on repairs, which should be made by an agreed method (see GN 8.04).

For hot dip galvanized coatings, the inspector should check that the coating thickness meets the specification, the surface is uniform in appearance and reasonably smooth. Variations in colour and texture are acceptable, because these vary according to the steel chemistry, steel thickness and processing. The appearance of uncoated areas, flux and ash inclusions, distortion and damage should be causes for rectification and if serious even rejection. Any defects that are repairable should be noted and further checks made on the repairs. (For guidance on the repair of galvanized coating, see GN 8.03.)

Metal coating thickness measurement

The thickness of metal coatings is measured using standard non-destructive methods (e.g. an electromagnetic induction paint thickness gauge). There may also be specified requirements for adhesion testing for thermal sprayed coatings either on representative sample panels or on production items. More information can be found in BS EN ISO 2063-1 [7] for thermal sprayed coatings, and BS EN ISO 1461 [8] for hot dip galvanized coatings.

In the event of dispute as to the coating thickness achieved as measured non-destructively, the coating may be destructively measured either via microscopic examination to BS EN ISO 1463 [9] or gravimetric testing to BS EN ISO 1460 [10]. Provided the area of a coating can be accurately determined, and in the absence of more advanced testing, the gravimetric method should be the definitive test

Inspection and testing of paint coatings

Paint coating systems are usually multi-coat systems and it is important to make checks at each coating stage. Visual checks should be made for obvious coating imperfections, contamination and defects. Measurements of coating thickness should be made on both wet and dry film thicknesses during and after the paint application process, as below.

In addition, there is sometimes a requirement to undertake other tests such as for adhesion (pull off testing) and porosity or pinholes (holiday 'spark' test). Where spark testing is used the test voltage shall be agreed to avoid undue damage to an otherwise sound paint film.

Measurement of paint coating thickness

Wet film thickness

Wet film thickness (wft) checks are usually required during the application of the coating to check that a subsequent satisfactory dry film thickness will be achieved. The most common instrument is the wet film comb. Disposable plastic types can be used once only, to speed up measuring.

As well as measuring wet film thicknesses directly, the amount of paint used allowing for wastage, can also give an indication as to problems of under or over applying paint.

Dry film thickness

An important factor in the inspection of the coating system is the measurement of the dry film thickness (dft). Dry film thickness is generally measured on the complete paint system, although individual films may be required to be checked separately as application progresses (minimum values for each coat are usually stated in specifications). Note the individual readings of coating thicknesses can be proportionally slightly lower than the nominal thickness as it is unlikely isolated thin areas will occur above each area in the finished coating.

As mentioned previously, what the specified dft is and actually means should be clear in the specification. It must be appreciated that most dft gauges can be calibrated in various ways and that different methods of calibration may give different values on the same surfaces being checked.

One common method of measuring dft is to use a calibrated digital electromagnetic induction paint gauge. The accuracy of the gauge should be checked periodically during use against calibrated thickness shims. Some paint coatings can take time to fully cure to surface hard condition, even if they are cured sufficiently for overcoating. In this case to avoid underreading paint thickness by the gauge sinking into the paint film, offset shims should be used.

If an electromagnetic gauge is used on a coating over a blast cleaned substrate, the dry film reading will not take into account the profile of the blast cleaned substrate. One widely used method to compensate for this is first to obtain an average of the peak-to-trough height of the surface after surface preparation and before coating, and then subtract this value from the reading shown on the display of the gauge. Other methods require the use of smooth surface shims that are coated at the same time as the work piece. No surface profile then needs to be deducted.

It can be seen that it is essential that the specification makes clear what is required and how fulfilment of the requirement should be ascertained. In situations where the specification is lacking in these respects, it is important that agreement as to what the actual requirements are and how they are to be monitored is resolved prior to project commencement.

A significant number of measurements are required to determine whether the target thickness has been achieved. To avoid erroneous readings, measurements should not be taken within 12 mm of edges or holes etc.

As well as measuring the dft, the inspector should check that excessive film thickness is not applied. The 'over application' of paints can result in the formation of high stresses and may cause premature failure of the system.

In the case of dispute, a destructive method of examination may be required, such as the microscopic measurement method described in BS EN ISO 2808 [11].

References

[1] Manual of Contract Documents For Highway Works Specification for Highway Works, Series 1900: Protection of Steelwork against Corrosion. 2014, TSO.

[2] NR/L3/CIV/040: Network Rail Standards, Level 3 Work Instruction, for the use of protective coating systems, June 2023.

[3] National Highways Sector Scheme 19A, Corrosion Protection Of Ferrous Materials By Industrial Coatings, June 2020

[4] BS EN ISO/IEC 17024:2012 Conformity Assessment. General requirements for bodies operating certification of persons

[5] BS EN ISO 12944-7:2017 Paints and varnishes. Corrosion protection of steel structures by protective paint systems - Execution and supervision of paint work

[6] BS EN 45020:2007 Standardization and related activities. General vocabulary. (Cross references BS EN ISO/IEC 17000.)

[7] BS EN ISO 2063-1:2019 Thermal spraying. Zinc, aluminium and their alloys – design considerations and quality requirements for corrosion protection systems.

[8] BS EN ISO 1461: 2022, Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods

[9] BS EN ISO 1463: 2021, Metallic and oxide coatings. Measurement of coating thickness. Microscopical method

[10] BS EN ISO 1460: 2020, Metallic coatings. Hot dip galvanized coatings on ferrous materials. Gravimetric determination of the mass per unit area

[11] BS EN ISO 2808: 2019, Paints and varnishes – Determination of film thickness (ISO 2808:2019)

Other relevant Standards and further reading

[12] BS EN ISO 8501-1:2007, Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings

[13] BS EN ISO 8502-6:2020, Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness - Extraction of water soluble contaminants for analysis (Bresle method)

[14] BS EN ISO 8502-9:2020, Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness - Field method for the conductometric determination of water-soluble salts

[15] BS EN ISO 8503-1:2012, Preparation of steel substrates before application of paints and related products. Surface roughness characteristics of blast-cleaned steel substrates. Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces.

Steel Construction Website

www.steelconstruction.info/Corrosion_protection, BCSA, Steel for Life, SCI.

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