Corus Construction & Industrial

A corrosion protection guide

For steelwork exposed to atmospheric environments

Surface protection guide for steelwork exposed to atmospheric environments

Exterior environments			
Environment category [a]		Corrosion risk	Typical steelwork location [b]
C3		Medium	Most rural and urban areas with low sulphur dioxide, acid, alkali and salt pollution.
C4		High	Urban and industrial atmospheres with moderate sulphur dioxide pollution and/or coastal areas with low salinity.
C5	C5I	Very high	Industrial areas with high humidity and aggressive atmospheres.
	C5M		Coastal and offshore areas with high salinity.

Specifiers are advised to seek specialist advice for the protection of steelwork used in road or rail bridges, buried in the ground or immersed in water.

Notes

a) Environment Categories C3/C4/C5 above are based on those given in BS EN ISO 12944 and ISO 9223.

b) There may be times or locations where the corrosivity category is higher than expected. For example, lighting columns that may be located in environment category C3 may be subjected to local conditions that may be equivalent to category C5M when salt is spread on the roads and pavements during winter.

List of standards

BS EN ISO 12944: 1998	Paints and varnishes corrosion protection of steel structures by protective paint systems.
BS EN ISO 14713: 1999	Protection against corrosion of iron and steel in structures – Zinc and aluminium coatings – Guidelines.
BS EN ISO 1461: 1999	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.
BS EN 10240: 1998	Coatings for steel tubes: Specification for hot dip galvanized coatings.
ISO 4628-3: 1982	Paints and varnishes – Evaluation of degradation of paint coatings – Designation of intensity, quantity and size of common types of defect – Part 3: Designation of degree of rusting.
BS 7079: Part A1 (ISO 8501-1)	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
ISO 9223: 1992	Corrosion of metals and alloys – Corrosivity of atmospheres – Classification.
BS EN 22063: 1994	Metallic and other inorganic coatings – Thermal spraying – Zinc, aluminium and their alloys.

Notes to table (overleaf)

1. Coating system durability given in the table is based on practical experience. It is the expected life, in years, before first major maintenance (See MAINTENANCE below). This is taken as degradation level Ri3 from ISO 4628 Part 3 (1% of surface area rusted). It should be noted that this does not imply a guarantee of life expectancy.
2. The durability of galvanized steelwork is derived from the figures in BS EN ISO 14713.
3. Where painting of galvanized steelwork is required for aesthetic or other reasons; suitable systems from BS EN ISO 12944 may be used.
4. The thickness values given for primers are the total thickness used and may include a pre-fabrication primer. For example – 80µm can be in one coat or as 20µm pre-fabrication primer plus 60µm post-fabrication primer.
5. Costs given here are for guidance only. There will be considerable variation that may typically be +/- 50% for a variety of reasons. Quotations should be obtained before making the final selection of the protective treatment. The indicative costs given are for 2004. They include estimates for material and labour but exclude taxes. The average surface area/tonne is assumed to be 25m²/tonne.
6. It should be noted that the colour range of micaceous iron oxide (MIO) is limited.
7. In some countries, the use of sprayed zinc or alloys of zinc and aluminium may be preferred (BS EN 22063).
8. The zinc rich primer applied at 80µm would increase the durability of the system by approximately 5 years and increase the cost by £2.00/m².
9. For steelwork 6mm thick or greater, the minimum average coating thickness is 85µm.

		Environment category C3					
System number		B12		B14		B15	
Anticipated durability of the coating system in years (notes 1 & 2) for environment category	C3	40		20		20	
	C4	30		15		15	
	C5	15(C5I)/20(C5M)		10		10	
Nearest equivalent BS EN ISO 12944		–		S1.34		S1.31	
Shop applied	Surface preparation (BS 7079: Part A1)	–		Blast clean to Sa 2½		Blast clean to Sa 2½	
	Coatings (note 4)	Hot dip galvanize to BS EN ISO 1461	85µm	Zinc phosphate epoxy primer (note 4) High build epoxy MIO	80µm 100µm	High solid epoxy zinc phosphate primer High solid aliphatic polyurethane finish	100µm 100µm
Site applied	Coatings	None (note 3)		Recoatable polyurethane finish	60µm	None	
Approximate cost in £/m² (note 5)		8.00		11.50		8.85	

General notes

This document gives details of corrosion protection systems for steelwork exposed to atmospheric environments.

Design

The rate at which corrosion occurs largely depends on the period of wetness. Steelwork should, wherever possible, be designed to shed rainwater and condensation. Any details that collect or retain water should be redesigned or incorporate adequate drainage. Detailed advice may be obtained from BS EN ISO 12944 or BS EN ISO 14713.

Coating thickness

The film thicknesses given in the table are nominal dry film values (µm = micron = 0.001mm). Coating thicknesses have been chosen in accordance with the principles of BS EN ISO 12944.

Workmanship

It is assumed that the quality of work and any repairs will be to an acceptable professional standard and in accordance with the coating manufacturers recommendations.

Surface preparation

Correct surface preparation is essential for satisfactory performance of coatings. Thorough removal of grease, dirt, rust and loose paint must be carried out before application of all coatings.

Coating systems

Steelwork fabricators' process routes vary. The sequence may be a) Blast – Fabricate – Prime or b) Blast – Prime – Fabricate or c) Fabricate – Blast – Prime. The choice of sequence depends on the facilities available to the fabricator or applicator, and the size of the structural members. A prefabrication primer may or may not be needed, depending on the sequence chosen. Under certain circumstances, some of the coats given in treatments as 'site-applied' may be applied in the shop if preferred. Similarly, some treatments given as 'shop-applied' may be applied on site.

Galvanized components

The weathering of zinc/iron alloy layers of the galvanized coating can give the appearance of superficial rusting many years before the durability limit has been reached. Where galvanized steelwork is affected by 'white rust' (wet storage stain) this should be removed with a stiff brush and washed with water before subsequent pre-treatment and coating.

Environment category C4		Environment category C5					
E6		E8		E9		E11	
25		30+		30		40+	
15-20		20-25		25		30+	
12		15		20		20+	
S1.35		–		S5.06		–	
Blast clean to Sa 2½		Blast clean to Sa 3		Blast clean to Sa 2½		–	
Zinc rich epoxy primer High build epoxy MIO	40µm 100µm	Sprayed aluminium to BS EN 22063 (note 7). Zinc phosphate epoxy sealer coat High build epoxy MIO	150µm 50µm 100µm	Zinc rich epoxy primer (note 8) High build epoxy MIO (one or two coats)	40µm 200µm	Hot-dip galvanize to BS EN ISO 1461 (note 9) Mordant wash Epoxy primer High build epoxy MIO	 40µm 100µm
High build epoxy MIO (note 6)	100µm	Recoatable polyurethane finish	60µm	High solid aliphatic polyurethane finish	80µm	Recoatable polyurethane finish	60µm
11.50		30.00		15.00		24.00	

Galvanized or sherardized fasteners should be used with galvanized steelwork.

Fire protection

Corrosion protection and fire protection are sometimes required together. If such an occasion arises, advice should be sought from the manufacturer of the fire protection system.

Concrete encasement

Structural steel fully encased in concrete is not normally coated. It is suggested that the provisions of Eurocode 2 and/or Eurocode 4 should be followed. The concrete should have the correct composition and compaction with a depth of cover appropriate for the environment. Further guidance can be found in BS 8110, Part 1. As an alternative to concrete encasement, steelwork in corrosive environments e.g. below ground level, can be protected by the application of a high build epoxy coating to 450µm after suitable blast cleaning. Where steel is partially embedded in concrete in environments C3, C4 and C5, e.g. at column bases, extra protection should be provided at the steel/concrete junction by means of an alkali resistant paint at the junction or an alkali resistant mastic at the joint.

Environmental issues

The handling and application of all protective coatings must be carried out in accordance with the manufacturer's recommendations and comply with the requirements of relevant environmental legislation.

Handling and transport

Care in handling to minimise mechanical damage is essential to the performance of the protective system. The responsibility for the repair of damaged coatings should be clearly defined.

Site storage

Incorrect storage on site before erection can accelerate the deterioration of coatings. Steelwork should be supported off the ground with items separated by wooden battens allowing free circulation of air. Avoid ‘ponding’ (retention of standing water) by laying down steelwork to ensure adequate drainage.

Hollow sections

It is unnecessary to coat the interior of sealed hollow sections.

Maintenance

The first major maintenance is recommended when the level of coating degradation reaches Ri3 as illustrated in ISO 4628 Part 3 (1% of surface area rusted).

Exterior steelwork – surface protection

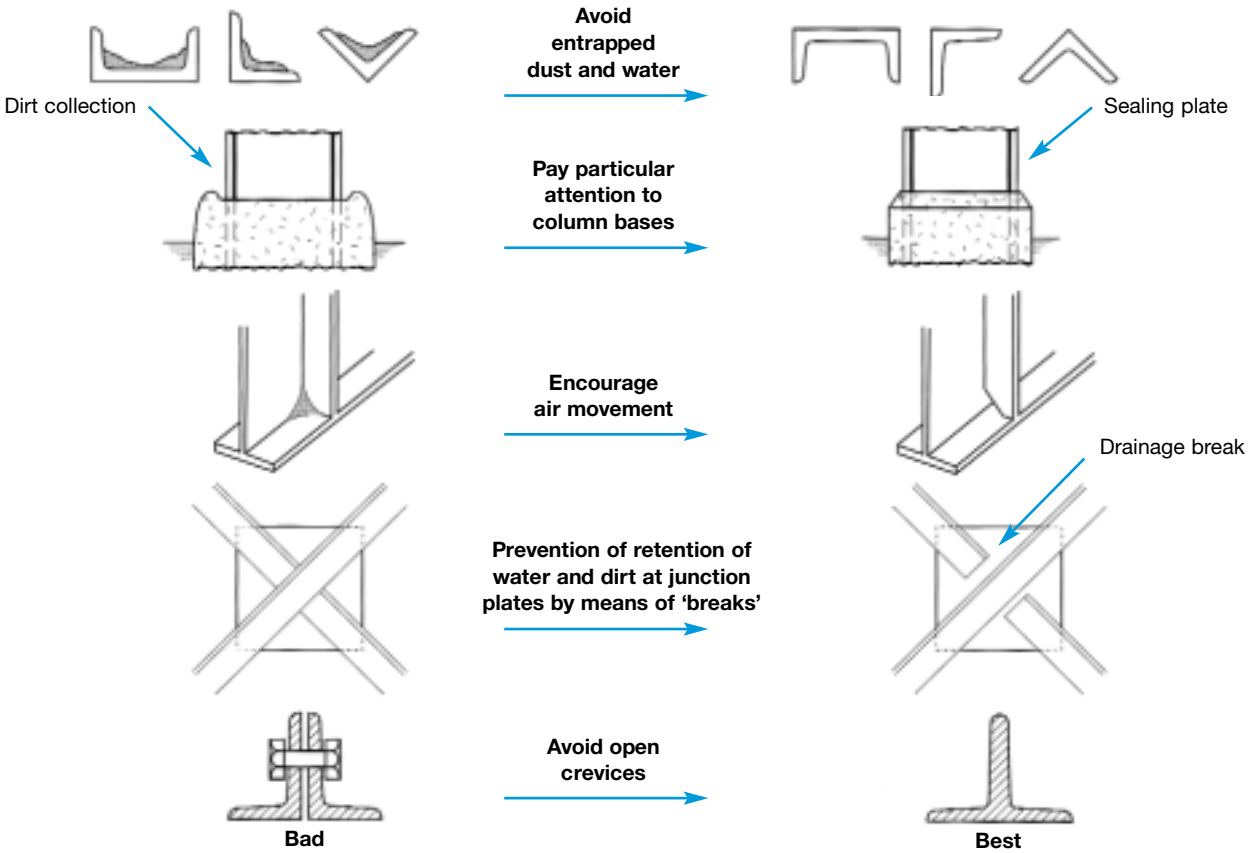
This document is intended to provide guidance to engineers and architects concerned with the design of new structures. Where possible, the document is in accordance with existing and proposed standards and represents a consensus of the experience of different European countries.

The document does not seek to cover every possible case. The systems suggested are considered to be reasonable, cost effective methods of providing protection in normal European environments.

There is no intention to restrict the specifier's field of choice. In some circumstances other methods of protection not given here may be economic as well as beneficial. New coatings are being developed continuously and the authors wish to encourage such development. Environments have been divided into three categories, but there will be variations around and within these categories. For this and other reasons, specifiers must use their judgement and, where necessary, take advice in selecting the optimum system. Any of the contributing bodies, or the manufacturers of protective systems, will be pleased to offer advice on systems for individual projects.

Some examples of detailing to minimise corrosion

Details should be designed to enhance durability by avoiding water entrapment.



Other sources of advice

The British Constructional Steelwork Association Ltd
4 Whitehall Court
Westminster
London SW1A 2ES
T 0207 839 8566
F 0207 976 1634

Paint Research Association
Waldegrave Road
Teddington
Middlesex TW11 8LD
T 0208 614 4800
F 0208 943 4705

Galvanizers Association
Wren's Court
56 Victoria Road
Sutton Coldfield
West Midlands B72 1SY
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