

# A corrosion protection guide

For steelwork in building interiors & perimeter walls



# Building interiors – surface protection

This document is intended to provide guidance to engineers and architects concerned with the design of new buildings. It suggests a range of corrosion protection systems for the structural framework of buildings which will be clad and protected from the weather. 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 and systems designed to meet environmental legislation are included.

There is no intention to restrict the specifiers' 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 are divided into 3 categories for both visible and hidden steelwork 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.

## 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  
T 0121 355 8838  
F 0121 355 8727

Interior environments			
Environment category	Corrosion risk		Typical steelwork location
C1	Very low	Because steelwork in a warm dry interior will not corrode, the structural stability of a building will not be threatened during its design life (generally taken as over 50 years).  In such conditions <b>no coating is required.</b>	Inside dry buildings with neutral atmospheres:  Offices, shops, schools, hotels, residences, airport terminals, hospitals, etc.
C2	Low	When steelwork is exposed to moisture corrosion will occur at a rate depending on the severity of the environment.  In low risk environments <b>systems B2, B3, B4, B9, B10 or B11 are proposed.</b>	Inside buildings where condensation may occur:  Exhibition halls, vehicle depots, sports halls, etc.
C3	Medium	In medium risk environments higher grade <b>systems B5, B6, B7, B12, B13, B14 or B15 are proposed.</b>	Inside production buildings with high humidity and some pollution:  Food processing plants, dairies, laundries, breweries, etc.

C4	High	<b>High corrosion risk atmospheres are not covered by this guide. Users are advised to seek specialist advice.</b>	Buildings with high humidity and corrosive atmospheres:
C5 Industrial	Very high		Chemical processing plant, swimming pools, dye works, paper manufacturing plants, boat yards over sea water, foundries, smelters, etc.
C5M Marine	Very high		

## Notes

Environment categories are based on those given in BS EN ISO 12944.

Buildings may contain areas where different conditions apply, e.g. hospitals (C1) will contain kitchen and laundry areas (C3).

Some types of buildings, such as agricultural or car parks, may fall into any of the above categories depending on their location and content.

Building interiors – hidden steelwork									
Environment category		C1 Very Low Risk		C2 Low risk					
System number		B1		B2		B3		B4	
Possible life (see note 1)		Structure Life	Coating Life	Structure life	Coating life	Structure life	Coating life	Structure life	Coating life
		60+	N/A	50+ (note 10)	N/A	55+ (note 10)	N/A	(note 11)	N/A
Nearest Equivalent BS EN ISO 12944		–		–		S1.01 or S1.03		S2.12	
Shop applied	Surface preparation (BS 7079: Part A1)	No Protection		None		Blast clean to Sa 2½		Blast clean to Sa 2½	
	Coatings			None		Zinc phosphate epoxy primer (note 3)	80µm	Water-based acrylic or water-based epoxy zinc phosphate primer – 2 coats	2x60µm (120µm total)
Site applied	Surface preparation (BS 7079: Part A1)	No Protection		Manual clean to CSt 2		None		None	
	Coatings			High build bitumen	150µm	None		None	
Approximate cost in £/m <sup>2</sup> (see note 2)		0		4.40		4.80		7.50	

## Notes to table

- In deriving the protection systems in this document the design life of building structures has been taken as 50 to 60 years. The table gives two figures for durability:
  - Structure life**  
The period of reasonable freedom from severe corrosion of the steelwork that might lead to weakening of the structure. This figure assumes no mechanical damage in service, that no maintenance is carried out and that up to 1mm of steel may be lost from the surface at the corrosion rate for each environment given in BS EN ISO 12944. Visible steelwork will normally be accessible for maintenance and if repainting is carried out the quoted structure life will be extended.
  - Coating life**  
The expected period to maintenance of the protective coating. More frequent re-coating may often be preferred for decorative reasons because of fading, contamination, wear and tear, etc. Hidden steelwork is assumed to be not accessible for maintenance, thus a figure for coating life of hidden steelwork systems is not applicable.
- Costs given here are for guidance only. There will be considerable variation, which typically may be ±50%, for a variety of reasons. Quotations should be obtained prior to making the final selection of the protective treatment. The indicative costs given are for 2004. They include estimates for material and labour. The average surface area/tonne is assumed to be 25m<sup>2</sup>/tonne.
- 80µm can be in one coat or as 20µm pre-fabrication primer plus 60µm post-fabrication primer.
- A 'wetting' low viscosity primer is recommended to obtain satisfactory performance.
- Alternatively a primer specially formulated for use on fresh galvanized surfaces may be used.
- For steel profiles over 6mm thick the minimum average galvanized coating thickness is 85µm.
- If painting is required for decorative reasons, any minimal system which satisfies the decorative requirement is sufficient.
- Where the appearance of a galvanized surface is satisfactory it may be left uncoated, but for extended life it would normally be maintenance painted before the zinc layer has disappeared which could be in excess of 40 years. The subsequent maintenance period will then depend on the paint system chosen.
- Where a coloured surface is preferred the 10 year figure is for maintenance of the decorative paint coating only (which is in addition to up to 40 years life of the zinc layer).
- When a structure durability period in excess of 60 years is required systems B5, B6 & B7 may be used in environment C2.
- Water based coating technology is still developing and advice on durability should be obtained from coating manufacturers.

C3 Medium risk					
B5		B6		B7	
Structure life	Coating life	Structure life	Coating life	Structure life	Coating life
55+	N/A	60+	N/A	55+	N/A
S1.40		–		S1.31	
Blast clean to Sa 2½				Blast clean to Sa 2½	
Hydrocarbon modified epoxy	300µm	Hot dip galvanize to BS EN ISO 1461 (note 6)	High solid epoxy zinc phosphate primer (note 3)	80µm	
			High build recoatable epoxy micaceous iron oxide (MIO)	120µm	
None		None		None	
None		None		None	
6.60		8.00		7.50	

C1 Very low risk		C2 Low risk			
B8		B9		B10	
Structure life	Coating life	Structure life	Coating life	Structure life	Coating life
60+	N/A	50	10	55	15
–		S1.10		S1.09	
–		None		Blast clean to Sa 2½	
No protection		None		High build zinc phosphate epoxy primer (note 3)	80µm
–		Manual clean to CST 2		–	
No protection (note 7)		Zinc phosphate alkyd primer (note 4)	40µm	Alkyd finish	60µm
		High build zinc phosphate alkyd primer alkyd finish	80µm 60µm		
0		8.75		7.50	

### General notes

This document gives details of corrosion protection systems for steelwork inside buildings and in building facades.

### Coating thickness

Film thicknesses given in the table are nominal dry film values (µm = micron = 0.001mm).

### Workmanship

It is assumed that the quality of work 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 and dirt, rust and loose paint must be carried out prior to application of all coatings. Where manual cleaning is to be used this should only be done after an adequate weathering to loosen the mill scale in accordance with BS 7079 Pt A1 rust grade C.

### 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 pre-fabrication 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 within 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.

Many components, e.g. purlins, are manufactured from pre-galvanized steel sheet typically with a zinc coating of 25µm thickness. These may be left bare in dry heated interiors. The durability and times to first maintenance of such components may not be identical to those for structural steelwork indicated in the above table.

Building interiors – visible steelwork										
		C3 Medium Risk								
B11		B12		B13		B14		B15		
Structure life	Coating life	Structure life	Coating life	Structure life	Coating life	Structure life	Coating life	Structure life	Coating life	
(note 11)		60+	40 (note 8)	60+	40(10+) (note 9)	45	25	40	20	
S1.12 or S1.27		–		–		S1.34		S1.34		
Blast clean to Sa 2½		–		–		Blast clean to Sa 2½		Blast clean to Sa 2½		
Water-based acrylic or water-based epoxy zinc phosphate primer	60µm	Hot dip galvanize to BS EN ISO 1461 (note 6)		Hot dip galvanize to BS EN ISO 1461 (note 6)		Zinc phosphate epoxy primer (note 3)	80µm	High solid epoxy zinc phosphate primer (note 3)	100µm	
						High build epoxy MIO	100µm	High solid aliphatic polyurethane finish	100µm	
–		None		Mordant wash (note 5)		None		None		
Water-based acrylic or water-based epoxy finish	60µm	None		Vinyl primer	40µm	Recoatable polyurethane finish	60µm	None		
				Vinyl finish	60µm					
9.00		8.00		12.50		11.50		8.85		

Galvanized or Sherardized bolts should be used for 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 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 C2 and C3, 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 manufacturers' recommendations and comply with the requirements of relevant environmental legislation. Systems B4, B7, B11 and B15 are included to give specifiers the option of further reducing the emission of organic solvents. Specifiers are advised to check the national requirements.

### 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

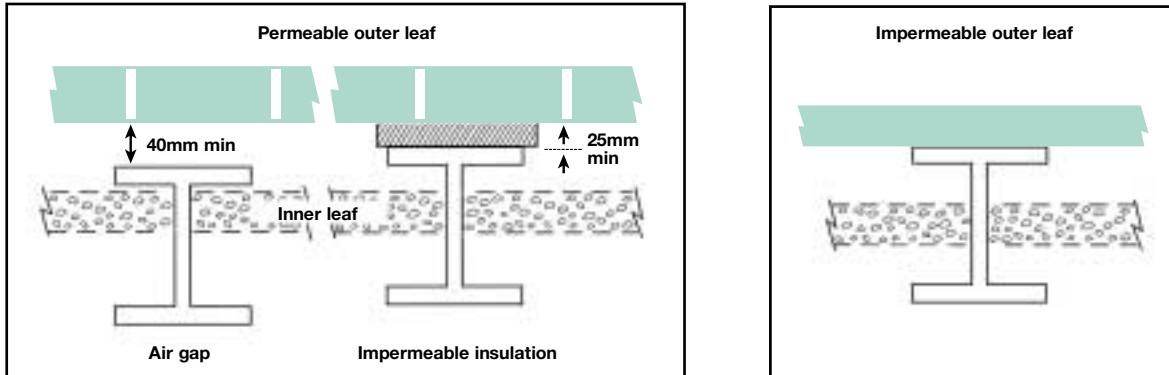
Incorrect storage on site prior to erection can accelerate the deterioration of coatings. Steel work should be supported off the ground with items separated by wooden battens allowing free circulation of air. Avoid 'ponding' (retention of standing water) by laying down sections to ensure adequate drainage.

### Hollow sections

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

## Steelwork in facades

For wall cavities in which steel will remain dry, either by use of an impermeable outer skin or where there is physical separation of the steel from the outer skin, a system from the 'hidden steelwork' section appropriate to the internal building environment category (C1, C2, or C3) may be used.



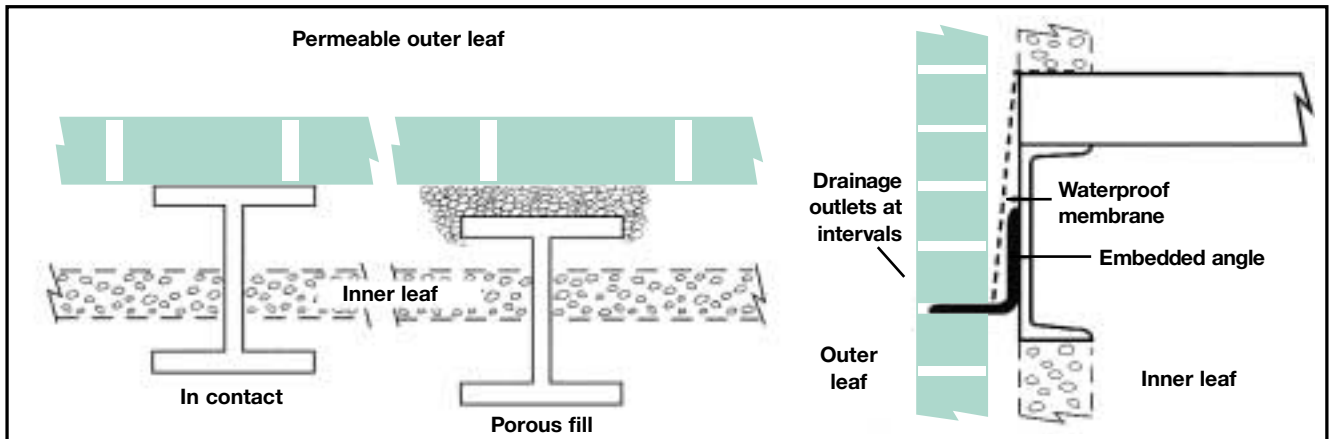
### Steelwork in clear separation from outer leaf

System number	Surface preparation	Coatings	Thickness (dft)	Approximate cost (£/m <sup>2</sup> )
B3	Blast Clean Sa 2½	1 coat Zinc phosphate epoxy primer	80µm	£4.80

**Notes:**

- As an alternative, zinc phosphate alkyd primers are currently permitted under the Environmental Protection Act, Process Guidance Note PG6/23 (97 Amendment) for shop application providing that they are specified as a single coat (primer/finish) treatment and are not to receive any additional coats. Specifiers should be aware that the requirements of PG6/23 may be amended in the future.
- The treatment specified for cavity wall conditions should also be suitable for the interior environment of the building.

Brickwork cladding or other masonry, can develop cracks and leakage over time. When steelwork is in contact with, or embedded in a brick outer skin one of the following systems should be used.



### Steelwork in contact with masonry outer skin

System number	Surface preparation	Coatings	Thickness (dft)	Approximate cost in £/m <sup>2</sup>
B16	Blast clean to Sa 2½ off-site	One coat solvent free epoxy	450µm	8.50
B17		Hot dip galvanize (BS EN ISO 1461) plus 2 coats heavy duty bitumen	85µm 200µm	13.60
B18	In some regions stainless steel may be required for embedded members by local regulations or be deemed necessary to provide adequate durability. Specialist advice should be sought.			

