A corrosion protection guide

For steelwork exposed to atmospheric environments
Surface protection guide for steelwork exposed to atmospheric environments

<table>
<thead>
<tr>
<th>Environment category</th>
<th>Corrosion risk</th>
<th>Typical steelwork location</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3</td>
<td>Medium</td>
<td>Most rural and urban areas with low sulphur dioxide, acid, alkali and salt pollution.</td>
</tr>
<tr>
<td>C4</td>
<td>High</td>
<td>Urban and industrial atmospheres with moderate sulphur dioxide pollution and/or coastal areas with low salinity.</td>
</tr>
<tr>
<td>C5</td>
<td>C5I</td>
<td>Industrial areas with high humidity and aggressive atmospheres.</td>
</tr>
<tr>
<td>C5</td>
<td>C5M</td>
<td>Coastal and offshore areas with high salinity.</td>
</tr>
</tbody>
</table>

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 1461: 1999 Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.

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.
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 C3

<table>
<thead>
<tr>
<th>System number</th>
<th>Environment category C3</th>
</tr>
</thead>
<tbody>
<tr>
<td>B12</td>
<td></td>
</tr>
<tr>
<td>B14</td>
<td></td>
</tr>
<tr>
<td>B15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anticipated durability of the coating system in years (notes 1 &amp; 2) for environment category</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3</td>
</tr>
<tr>
<td>C4</td>
</tr>
<tr>
<td>C5</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Nearest equivalent BS EN ISO 12944</th>
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<tbody>
<tr>
<td>–</td>
</tr>
<tr>
<td>S1.34</td>
</tr>
<tr>
<td>S1.31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shop applied</th>
<th>Surface preparation (BS 7079: Part A1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coatings</td>
<td>Hot dip galvanize to BS EN ISO 1461</td>
</tr>
<tr>
<td>85µm</td>
<td></td>
</tr>
<tr>
<td>Zinc phosphate epoxy primer (note 4)</td>
<td></td>
</tr>
<tr>
<td>80µm</td>
<td></td>
</tr>
<tr>
<td>High build epoxy MIO</td>
<td></td>
</tr>
<tr>
<td>100µm</td>
<td></td>
</tr>
<tr>
<td>High solid epoxy zinc phosphate primer</td>
<td></td>
</tr>
<tr>
<td>100µm</td>
<td></td>
</tr>
<tr>
<td>High solid aliphatic polyurethane finish</td>
<td></td>
</tr>
<tr>
<td>100µm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Site applied</th>
<th>Coatings</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (note 3)</td>
<td></td>
</tr>
<tr>
<td>Recoatable polyurethane finish</td>
<td></td>
</tr>
<tr>
<td>60µm</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Approximate cost in £/m² (note 5)</th>
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</thead>
<tbody>
<tr>
<td>8.00</td>
</tr>
<tr>
<td>11.50</td>
</tr>
<tr>
<td>8.85</td>
</tr>
</tbody>
</table>

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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.

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**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.

- Avoid entrapped dust and water
- Pay particular attention to column bases
- Encourage air movement
- Prevention of retention of water and dirt at junction plates by means of ‘breaks’
- Avoid open crevices

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
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