



STEEL INDUSTRY
GUIDANCE NOTES

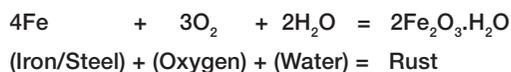
The prevention of corrosion on structural steelwork

The cost effective corrosion protection of structural steelwork should present little difficulty for common applications and environments if the factors that affect durability are recognised at the outset. This note aims to give specifiers an insight into the factors involved.

In dry heated interiors no special precautions are necessary. Where precautions are required modern durable protective coatings are available which, when used appropriately, provide extended maintenance intervals and improved performance.

The corrosion process

Most corrosion of steel can be considered as an electrochemical process that occurs in a series of consecutive stages. The details of this process can be summarised by the following equation:-



From this it can be seen that for iron and steel to corrode it is necessary to have the simultaneous presence of water and oxygen. In the absence of either, corrosion does not occur.

What affects the rate of corrosion?

The principle factors that determine the rate of corrosion of steel in air are the time of wetness and the presence of atmospheric pollution typically present as sulphates and chlorides.

- **Time of wetness**
This is the proportion of total time during which the surface is wet, due to rainfall, condensation, etc.
- **Sulphates**
These originate from sulphur dioxide gas that is produced during the combustion of fossil fuels,
- **Chlorides**
These are mainly present in marine environments. The highest concentrations of chlorides are to be found in coastal regions and there is a rapid reduction when moving inland.

Both sulphates and chlorides increase corrosion rates. They react with the surface of the steel to produce soluble salts of iron that can concentrate in pits and are themselves corrosive.

Because of variations in atmospheric environments, corrosion rate data cannot be generalised, however, environments and corresponding corrosion rates are broadly classified in BS EN ISO 12944 Part 2 and ISO 9223

The effect of design on corrosion prevention

In external or wet environments, design can have an important bearing on the corrosion of steel structures. In dry heated interiors no special precautions are necessary. The prevention of corrosion should therefore be taken into account during the design stage of a project. The main points to be considered are:

- **To avoid the entrapment of moisture and dirt**
The key here is to avoid the creation of cavities and crevices; so welded joints are preferable to bolted joints. Lap joints should be avoided or sealed where possible. Additionally drainage holes to prevent standing water may have to be incorporated.
- **Coating application**
The design should ensure that the selected protective coatings can be applied efficiently. Typically this might involve ensuring adequate access for painting or adding drain/vent holes to sealed components, which will be subject to hot dip galvanizing.

The application of protective coatings

Surface Preparation

The surface preparation of steel is concerned with the removal of mill-scale, rust and other contaminants to provide a satisfactory substrate for coating and is generally considered to be a two stage process

The first stage of any surface preparation is to remove residues of grease, oil or marking inks. The second stage is to remove any mill scale and rust and is generally done by either hand and power tool cleaning or abrasive blast cleaning.

Painting

Painting is the principle method of protecting structural steelwork from corrosion.

Paints are made by mixing, pigments (the coloured part), binders (the film forming component) and the solvent (which dissolves the binder).

Paints are usually applied one coat on top of another and each coat has a specific function or purpose.

The primer is applied directly onto the cleaned steel surface. Its purpose is to wet the surface and to provide good adhesion for subsequently applied coats. In the case of primers for steel surfaces, these are also usually required to provide corrosion inhibition.

The intermediate coats (or undercoats) are applied to 'build' the total film thickness of the system. Generally, the thicker the coating the longer the life and this may involve the application of several coats.

The finishing coats provide the first line of defence against the environment and also determine the final appearance in terms of gloss, colour, etc.

Hot dip galvanizing.

The most common method of applying a metal coating to structural steel is by hot-dip galvanizing.

Following surface preparation as described earlier the galvanizing process involves the following stages:

- i. The cleaned steel is immersed in a fluxing agent to ensure good contact between the steel and zinc during the galvanizing process.
- ii. The cleaned and fluxed steel is dipped into a bath of molten zinc at a temperature of about 450°C. At this temperature, the steel reacts with the molten zinc to form a series of zinc/iron alloys integral with the steel surface.
- iii. As the steel workpiece is removed from the bath, a layer of relatively pure zinc is deposited on top of the alloy layers.

As the zinc solidifies it usually assumes a crystalline metallic lustre, often referred to as 'spangling'. The thickness of the galvanized coating is influenced by various factors including the size and thickness of the workpiece, the steel surface chemistry and the surface preparation of the steel.

Weathering Steels

Weathering steels are high strength, low alloy weldable structural steels that possess good weather resistance in many atmospheric conditions without the need for protective coatings. They contain up to 2.5% of alloying elements, e.g. chromium, copper, nickel and phosphorous. On exposure to air, under suitable conditions, they form an adherent protective rust patina. This acts as a protective layer that, with time, causes the corrosion rate to reduce until it reaches a low terminal level, usually between 2-5 years.

Key Points

1. In dry heated interiors no special precautions are necessary.
2. The corrosion of steel can be considered as an electrochemical process
3. For steel to corrode it is necessary to have the simultaneous presence of water and oxygen.
4. The principle factors that determine the rate of corrosion of steel in air are the time of wetness and the presence of atmospheric pollution.
5. The prevention of corrosion should therefore be taken into account during the design stage of a project.
6. Painting is the principle method of protecting structural steelwork from corrosion.
7. Hot dip galvanizing is the most common method of applying a metal coating to structural steel
8. Weathering steels are high strength, low alloy weldable structural steels that possess good weather

Further sources of Information

1. **The prevention of corrosion on structural steelwork, Corus. Available from www.corusconstruction.com.**
2. **BS EN ISO 12944 Paints and varnishes. Corrosion protection of steel structures by protective paint systems, BSI.**
3. **BS 7773 'Code of Practice for Cleaning and Preparation of Metal Surfaces'.**
For information on the specification of galvanizing contact the Galvanizing Association - www.galvanizing.org.uk