TECH NOTE 1.1.1

MILD STEEL – WHAT IS IT?

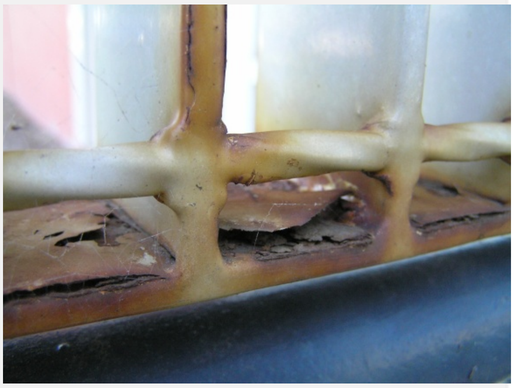
SUBSTRATE DESCRIPTION

Steel is derived from iron. Iron ore requires great thermal energy (around 1,500°C) to reduce to its metallic form of iron. The iron is then alloyed with carbon and metals such as nickel or tungsten to produce steel.

Steels are described as mild, medium- or high-carbon steels, according to the percentage of carbon they contain. Mild steel is an iron alloy that contains less than 0.25% carbon.

Mild steel is very reactive and will readily revert back to iron oxide (rust) in the presence of water, oxygen and ions. The readiness of steel to oxidize on exterior exposure means that it must be adequately protected from the elements in order to meet and exceed its design life.

Prior to painting, new mild steel surfaces should be inspected for millscale, rust, sharp edges, laminations, burr marks and welding flux, forming or machine oils, salts, chemical contamination or mortar splashes on them, all of which must be removed.



WHAT IS MILLSCALE?

Millscale is a shiny, bluish iron oxide often present on the surface of the steel. It is produced by heat and pressure during manufacture. Millscale is often mistaken for a blue-toned shop primer or clean steel. Millscale is very difficult to remove by hand and must be completely removed during surface preparation for long-term corrosion protection. The presence of millscale is responsible for a significant proportion of coating failures and thus must never be painted over. For more information, please refer to Dulux Protective Coatings Tech Note 1.1.4 – Millscale.

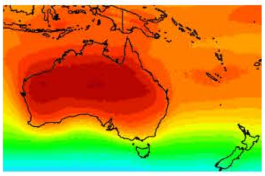
WHAT ARE LAMINATIONS?

Laminations are sections of steel that had been raised (such as burr edges) and then flattened at some stage of the rolling process – either hot-rolled or cold rolled. If not removed, these may harbour contaminants that could cause subsequent coating failure.

WHY USE STEEL?

Steel is an excellent choice of building material due to its high flexural and compressive strength. It allows the design of much taller multistorey buildings and structures with wider spans because of its high strength to mass ratio. It is also lighter to transport, quick to erect and is versatile in design.

“Steel has unique properties which make it a leading contributor to sustainable construction and to the long-term environmental performance of buildings of all descriptions. And at the end of a building’s life the recovered steel can either be reused or recycled into new steel products.” – Australian Steel Institute (ASI), www.steel.org.au.



WHAT IS CORROSION?

"The degradation of a material by electro-chemical reaction with its environment"

WHY DOES STEEL CORRODE?

Corrosion of steel is an electrochemical reaction that requires the presence of water (H_2O), oxygen (O_2) and ions such as chloride ions (Cl^-), all of which exist in the atmosphere. Atmospheric chloride ions are in greatest abundance near the coastline. This reaction starts when iron oxidises in the presence of water and ions.

The atmosphere also contains many other chemical emissions, such as carbon dioxide (CO_2), carbon monoxide (CO), sulphur dioxide (SO_2) and nitrous oxide (NO_2).

If any two dissimilar metals are in contact with each other, the more reactive metal will corrode in preference to the less reactive metal. This is the basis of galvanic battery cells.

HOW DO WE STOP STEEL FROM CORRODING?

There are three methods that may be used to protect steel.

1. PASSIVE BARRIER PROTECTION

Passive barrier protection works by coating the steel with a protective coating that forms a tight barrier to oxygen, water and ions. The lower the permeability of the coating system to water, the better the protection. Two-pack epoxy coatings and chlorinated rubbers applied at sufficiently high film builds offer the most successful corrosion protection through passive barrier protection.

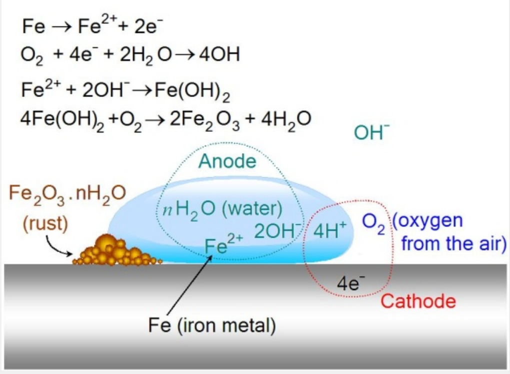
2. ACTIVE PROTECTION

Active corrosion protection occurs when a primer containing a reactive chemical compound is applied directly to the steel. The reactive compound disrupts the normal formation of anodes on the surface of the steel in some way. For example, inorganic zinc inhibitive pigments, such as zinc phosphate, offer active anti-corrosive protection to the steel substrate. Zinc phosphate ($Zn_3(PO_4)_2$) is only slightly soluble in water. It hydrolyses in water to produce zinc ions (Zn^{2+}) and phosphate ions (PO_4^{3-}). The phosphate ions act as anodic inhibitors by phosphating the steel and rendering it passive. The zinc ions act as cathodic inhibitors.

3. SACRIFICIAL PROTECTION (CATHODIC PROTECTION OR GALVANIC PROTECTION)

The above-mentioned reaction between dissimilar metals can be used to protect steel against corrosion. The most widely used metal for the protection of steel is zinc. Zinc metal in direct contact with the steel substrate offers protection through the preferential oxidation of zinc metal. Zinc is a great choice in protecting steel, as not only does it corrode in preference to the steel, the RATE of corrosion is generally lower. This rate, however, is accelerated in the presence of ions such as chlorides in coastal locations.

Examples of coatings using this principle of sacrificial protection include inorganic zinc silicates, organic zinc-rich primers, metal-sprayed zinc, hot dip galvanising and electroplating.



Corrosion mechanism

The highly reactive zinc layer of galvanised steel rapidly rusts when in contact with stainless steel.

The fallacy that millscale itself can protect steel has been proved spectacularly wrong!

Off shore platforms are often protected against corrosion by high build glass flake epoxy, which offers outstanding barrier protection. Sacrificial methods are inadequate in such an environment.

MILD STEEL – WHAT IS IT?

WHICH CORROSION PROTECTION IS BEST?

Dulux Protective Coatings recommends a combination of galvanic corrosion protection and barrier protection in most situations. Galvanic corrosion protection is best provided by either inorganic zinc silicates or zinc-rich epoxy primers, as both contain high levels of zinc metal. Please refer to PC Tech Note 3.8.1 Inorganic Zinc Silicates, and 3.8.2 Organic Zinc Rich Primers for more information.

For information on active corrosion protection by the use of DULUX Duremax GPE Zinc Phosphate primer, please refer to PC Tech Note 3.10.2 Duremax GPE Zinc ZP.

SURFACE PREPARATION IS IMPORTANT

Effective surface preparation is most important to achieve a uniformly clean and well-profiled surface to achieve maximum performance of the coating system.

The Australian Standard 1627 Series gives guidance on the selection of appropriate methods for the preparation of metal surfaces prior to the application of a protective coating.

AS1627.1 describes the procedure for removing oil, grease and related contamination. AS1627.4 describes the procedure for abrasive blast cleaning. For more details on our recommendations, please refer to Dulux Protective Coatings Tech Note 1.1.2 Mild Steel – Preparation and Painting.

COATING SYSTEM

The Australian Standard AS/NZS 2312:2002, “Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings” offers a comprehensive guide to coating systems based on environment and topcoat type. Alternatively, Dulux Protective Coatings offers a project-specific specification writing service, which can save you considerable time and money.

The type of coating system you choose largely depends on what environment your steelwork will be exposed to, and how you want the steel to look, but a typical coating system that provides excellent corrosion protection in most environments is the AS2312 PUR 5 system as follows, and includes a gloss polyurethane finish for protection against UV degradation:

STRUCTURAL STEEL		
Preparation: Ref AS1627.4, Sa 2 ½		
1st coat	Zinc rich epoxy primer @ 75µm	DULUX Zincanode® 402
2nd coat	High build epoxy @ 125µm	DULUX Duremax® GPE
3rd coat	Polyurethane finish @ 60µm	DULUX Luxathane® R

MAINTENANCE

Structural steel requires regular maintenance to ensure that the coating system is kept in good condition to continue to protect the steelwork from premature degradation. Regular maintenance scheduling must be carried out to identify and repair any problem areas to ensure that the coating system continues to offer corrosion protection and provide aesthetic appeal.

For more information, please contact the Dulux Protective Coatings Technical Consultant in your state.