BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE, INDIA

PAINTING FERROUS METALS IN BUILDINGS

Corrosion of metals is usually chemical and electro-chemical in nature. The composition, physical state and surface condition of the metal as well as the chemical components of the surrounding medium and their concentration determine the nature of the corrosion reaction. The corrosion of metals in buildings may cause distortion and cracking or disfigurement of other building materials in which the metal is embedded or with which it is in contact. Factors leading to corrosion are (1) faulty design that leads to lodging or entry of water or corrosive chemicals and (2) dissimilar metals in contact with each other.

To prevent corrosion, anodic and cathodic protection, changing the environment, and protective coatings can be employed. Protection of ferrous metals (iron and steel) in buildings by the application of paint is dealt with in this Digest.

Paint protects metals mainly by providing (a) a barrier effect between the metal surface and the surroundings, (b) an inhibiting effect, and (c) a sacrificial effect. The protection of the metal by paint film therefore depends upon the resistance it offers to the ingress of corrosive agencies and the extent to which it provides an inhibiting environment which can influence the electro-chemical process of corrosion.

Surface Preparation

Irrespective of the mechanism by which paint protects a metal, correct surface preparation is the most important single factor in ensuring the good performance of a painting scheme. The chemical and physical nature of a metallic surface has a marked effect on the performance of any coating applied to it. Differences in the type of steel appear to have practically no effect if the surface is carefully prepared. The preparation of the surface may involve many steps such as removal of grease, oils, and buffing compounds followed by pickling or sand blasting. Weld deposits and spatters should be ground smooth, and fluxing materials used in soldering should be removed by a solvent such as trichloroethylene or by washing with hot water Weld flux slag remaining adjacent to a weld seam is strongly alkaline. Under humid conditions, it saponifies the paint vehicle forming fatty acid soaps. The latter reduces adhesion of the paint film and increases its permeability to moisture.

Removal of Oils and Grease

Organic solvents and caustic alkalis are used for the removal of oil and grease from surfaces to be painted. The solvent used must be non inflammable, non-toxic, of high solvent power, inert towards metals, stable and low in specific heat and latent heat. Although hydrocarbons are the best solvents they are not generally preferred being highly inflammable. Trichloroethylene is mostly used in removing grease or oil. White spirit may also be used. On site, all that is usually possible is to thoroughly wipe over with a clean swab soaked with the solvent. The solvent must be changed frequently to prevent spreading of the oil and grease. Due precautions, depending on the type of solvent used, must also be taken to guard against fire and health hazard.

Alkali may also be used for cleaning. It is more efficient and less hazardous than solvent cleaning for the removal of heavy and carbonized oils from iron and steel surfaces. The job to be cleaned may be soaked in an alkaline bath or may be sprayed with the solution. The surface should be rinsed in dilute acid followed by water before painting.

Removal of Mill Scale

This is a layer of oxidised iron which varies considerably in thickness, structure and composition. Natural weathering loosens or removes mill scale by rusting but it is never uniform and wire brushing, chipping or hand scraping is always necessary. It is rather a poor method of preparing iron and steel for painting.

Acid Pickling

The best methods for the removal of millscale are acid pickling and mechanical abrasion. The durability of the paint system is increased manyfold when either of these methods is adopted for cleaning the surface. The pickling operation normally consists of immersing the metal in dilute sulphuric acid (4 to 5 per cent) at about 80°C until the millscale has been loosened or dissolved. For iron and steel it is better to pickle in phosphoric acid solution. Spent bath that becomes weak with constant use should be rejected. After pickling, the component should be washed down with hot water.

Mechanical Abrasion.

Grit or sand blasting is the most effective treatment for removing millscale. It is in fact a factory process and is seldom employed on site in cleaning metals in building. When properly carried out the process removes all mill-

scale and roughens the surface to improve mechanical adhesion. Blast cleaning must be followed by priming within about four hours or else much of the advantage will be lost because the active surface produced is prone to flash rusting. Best results are obtained when the priming coat of the paint is put on immediately. Blasting is not suitable for thin sheets.

Flame Cleaning

In recent years the flame cleaning method of preparing structural steelwork for painting has been introduced. It works on the principle that sudden heating causes loose millscale to flake off and also dehydrates any rust that may be present. Immediately after the passage of the flame any remaining loose millscale and rust are dusted down The priming coat of paint should be applied when the surface is still warm (35-55°C) to avoid any condensation on the prepared surface. The great advantage of the flame cleaning process is its mobility. It is therefore an effective process for maintenance purposes.

Phosphate Treatment

After removing the surface contaminants and millscale it is beneficial to apply a coat of nearly saturated solution of zinc, ammonium or sodium phosphate in phosphoric acid. It forms a micro-crystalline phosphate coating which prevents local rusting due to moisture condensation and provides a surface to which paint adheres more strongly than to plain untreated metal. A more recently developed phosphate treatment is known as "etch primer". It consists of polyvinyl butyral resin in a suitable solvent to which phosphoric acid and zinc chromate are added. In addition to providing an inhibiting environment it leaves a thin film of the synthetic resin on the surface It is best applied in clear weather and should be followed by a coat of a normal primer paint with a minimum of delay.

Paint Systems

A paint system normally consists of primer, undercoat and finishing coat. Each of these has a special function and should be mutually compatible. For this reason, it is good practice to obtain all the paints from one manufacturer. However, oil based primers are usually compatible with top coats from different sources. Certain systems e g., coal tar and epoxy paint are used alone without primer.

Methods of Application

As far as possible painting should be carried out when the air is reasonably warm and the humidity is not unduly high (not exceeding 85% R.H.). Paint should never be applied on damp surfaces. Each coat should be of the optimum thickness and should be applied in a uniform continuous layer.

Brush and spray application of the priming paint give better results than dipping and roll coating. Spraying is quicker and gives a more uniform coating. Both spray and roll coating are usually satisfactory on smooth surfaces. On rough surfaces primers are best applied by brush. On the other hand, brush marks left in brushed-on paint constitute points of weakness in the dry film. Spraying is advantageous for painting large areas. It may however, lead to condensation of moisture and the trapping of water within the paint film. Brushing and spraying will give roughly equivalent results when applied to correctly prepared surfaces in such a way as to yield dry paint film of equal thickness.

In general, the efficiency of a protective coating increases with its thickness. As a rough guide the final protective coating on an actual steel surface should not be less than 125 microns (5 mils) thick. The thickness of the priming paint should also be sufficient to cover the peaks on irregular steel surfaces. This needs a film thickness of about 37 microns (1.5 mils). Most paints tend to recede from sharp edges and from the crowns of corrugations or angles. In such places an extra strip coat of primer should be given before the first full coat is applied over the whole surface.

Priming

Priming paint, containing corrosion inhibiting pigments such as red lead, white lead, lead chromate, calcium plumbate, zinc chromate and zinc oxide gives the best results if applied directly to the surface. Two coats of primer paint are recommended for longer life. For certain industrial purposes, particularly where appearance is not the governing consideration, tar and bitumen paints may be used although their protective properties are considerably inferior to that of primers containing inhibitive pigments. These paints can be materially improved by the incorporation of drying oils and the addition of aluminium powder.

Primers containing a high proportion of zinc dust pigment, generally referred to as zinc rich primer are also being used increasingly. Since zinc is not resistant to acids or alkalis, all zinc rich primers need to be top coated with a minimum of delay in industrial areas.

For normal work where the surface has been well prepared, red lead (IS:102-1962) or zinc chromate primer are applied. Zinc chromate primer paints are non-toxic, and their media are usually quick drying. Sometimes they contain red oxide (IS:2074-1962) also. They produce thin films, are less tolerant of imperfectly cleaned surfaces and are less corrosion resistant than lead based primer. Zinc chromate primer has good rust inhibiting properties but relatively poor film forming qualities. Having excellent flow it tends to recede into the hollows of roughened metal, thus producing a film of uneven thickness Two coats of zinc chromate primer are therefore advised.

Where surface preparation is not adequate, it is necessary to specify slower drying primers that can penetrate more readily into the small particles of rust or scale left

on the surface. Red lead in oil primer paint (IS:102-1962) gives the best results. Red lead paint is however, unsuitable for spray or dip application. Cheap, quick drying primers pigmented with iron oxide are generally applied in interior locations.

Primer paint, after its application, should be covered with an undercoat without undue delay, because firstly the primer is not designed for weather resistance and secondly there can arise some adhesion trouble at a later stage. During this interval rust may spread under the primer paint and may necessitate surface preparation and priming once more to get good performance.

Undercoating and Finishing

The composition and properties of undercoating should be such as to be compatible with both the priming and the finishing paint (IS:1477, Part II-1963). Undercoat and finishing coat provide additional film thickness, water resistance and decorative appearance. In protective schemes undercoat and finishing coat are less differentiated than in a normal decorative work. The main function of the finishing paint is to protect the paint underneath. Consequently it is desirable that the finishing paint should be highly impermeable to moisture and corrosive gases and that it should possess the maximum possible resistance to disintegration by weathering.

Finishing paint containing red oxide of iron, aluminium paste or powder (IS:165-1950 and IS:166-1950) or micaceous iron ore preform well when applied over inhibitive primer paint. It is beneficial to incorporate lamellar pigments such as leafing aluminum powder, graphite or mica in the finishing paiht.

Synthetic resins such as alkyd and phenolic resins have been mostly used as the medium for finishing paint. These resins are also useful where decorative appearance is desired. Epoxy, polyurethane and unsaturated polyester resin coatings are highly resistant but more expensive. These are especially useful in marine and industrial areas. They are commonly obtained in the form of two component systems which are mixed just prior to application and usually have a short pot life.

Silicone resin modified alkyd paints pigmented with aluminium or zinc dust are applied where high heat resistance properties are required. Tar and bitumen finishing paints (IS: 158-1950) are most effective when used over red lead priming paint in linseed oil (IS: 102-1950) which has hardened for 15 to 30 days. They provide protection against water, salt and chemicals. In exposed situations they should be protected from sunlight by a coat of bitumen aluminium paint.

Maintenance

Repainting should not be delayed beyond the appearance of the first traces of rust. This avoids the more costly work of removing all the rust and paint at a later stage. Should rust develop to any appreciable extent, extensive cleaning and scraping to the bare metal will be necessary. Pickling is not generally possible; grit blasting and flame cleaning are relatively difficult and costly. Only manual cleaning is usually possible. The work should be undertaken as soon as the film starts showing defects such as excessive chalking and mild checking.

If the old film is sound, no elaborate surface preparation is necessary. The surface may be merely rubbed down to remove checked film, cleaned and one or two coats of a suitable finishing paint applied If there are areas where failure has occurred in the form of blisters or pimples of rust, they can be brought into good condition for painting by means of a thorough wire brushing which will remove nearly all the rust. The bare metal is then wiped with a solvent and given a coat of priming paint. When the rust is accompanied by flaking of the paint film or it covers more than 0.5 per cent of the area, the entire film should be carefully removed to the bare metal by solvent, alkali paint stripper, a blow lamp, scraper or wire brush. Repainting is then done as for a new surface.

There is a demand for short notes summarising available information on selected building topics for the use of Engineers and Architects in India. To meet the need, this Institute is bringing out a series of Building Digests from time to time and the present one is the 71st in the series. Readers are requested to send to the Institute their experience of adopting the suggestions given in this Digest.

Prepared by : Shiva Mohan Singh & Joseph George

Published by : P.L. De,
Central Building Research Institute,
Roorkee U.P. (India)
September 1969

UDC	69.025.3
SfB	Du5

Security Printers, Saharanpur (India)

LIST OF BUILDING DIGESTS AVAILABLE AT CBRI

37. Single and double under-reamed piles for foundations in Black Cotton Soils.
38. Painting of cement plastered surfaces.
39. Sound absorbing materials and their utility in acoustics and noise control.
40. Fenestrations for daylighting in the tropics
    Part II: The Sky component
41. Insertion of damp proof course in existing walls
42. Removal of stains from concrete floors
43. Doubly curved tile roofs
44. Hardboard and particle board
45: Precast cellular units for floors & roofs
46. Foamed concrete blocks: Part. I
47. Foamed concrete blocks, Part II: Laying and rendering
48- Brick earths of India
49 The design of windows for natural ventilation in tropics
50. Unit frame scaffolding
51. Plastics for buildings
52. Thermal data of building fabrics and its application in building design.
53. Pile load tests
54. Painting of wood and wood-based materials.
55 Termite control measures in building construction
56. Under-reamed piles for foundations (revised)
57 Index to Building Digests 23 to 53
58. Cement as a substitute for lead in jointing C.I. Pipes
59. Wood preservation
60. Distempers
61. Solar water heater
62. Window design for natural ventilation in tropics
63. Plastics pipes for water supply and drainage in buildings
64. Acoustical designing and speech communication
65. Efflorescence in brickwork.
66. Simplified soil boring & sampling through bentonite slurry
67. Deep sounding by CBRI cone penetration test
68. Manpower and materials requirements in buildings.
69. Sea water for making concrte
70 Industrial Floor Finishes

NOTE :

1. The above Issues are available from Director, Central Building Research Institute, Roorkee.
2. Registration fee for inclusion in the Mailing list for Building digests is @ Rs. 5/- for 10 issues/copies
3. Remittance may be made by M.O. in favour of Director, CBRI. Roorkee.

4. Digests 19 to 36 can be purchased Directly from
   M/S Security Printers, 159 Bomanji Road, Saharanpur.