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CODE OF PRACTICE FOR CORROSION PROTECTION OF LIGHT GAUGE STEEL SECTIONS USED IN BUILDING

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Indian Standard

CODE OF PRACTICE FOR CORROSION PROTECTION OF LIGHT GAUGE STEEL SECTIONS USED IN BUILDING

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 18 May 1967, after the draft finalized by the Metal Standards Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 The Indian Standards Institution took up the steel economy project at the request of Government of India in 1950 in order to conserve steel which was in short supply. A technical committee was set up to undertake this work under which a number of subcommittees and panels initiated work on specific subjects. The technical committee after detailed deliberations formulated an Indian Standard code of practice for the use of cold-formed light gauge steel structural members in general building construction (IS : 801-1958), and also an Indian Standard specification for cold-formed light gauge structural steel sections (IS : 811-1961*) was formulated subsequently. The use of cold-formed light gauge structural steel sections leads to considerable savings in steels on an average up to 40 percent. The only drawback for extensive use of light gauge steel structures relates to the thinness of members and corrosion particularly in a large country with varying climatic conditions like India. As early as in 1957 a separate panel was set up with a view to conducting necessary research and formulate suitable recommendations for protection of light gauge steel sections. The panel was entrusted with the work of developing accelerated tests to determine the quality of protective scheme and also to prepare a corrosion map of this country on the basis of corrosion potential.

0.2.1 With the active assistance of the following laboratories, a short-term corrosion test was conducted in different parts of India:

Central Electrochemical Research Institute, Karaikudi

Defence Research Laboratory (Materials), Kanpur

National Metallurgical Laboratory, Jamshedpur

National Test House, Calcutta

0.2.1.1 A long-term project on the same subject has been taken up by the Council of Scientific and Industrial Research (CSIR).

*Since revised.

0.2.2 In the formulation of this standards assistance has been derived from SIS 185111 'European scale of degree of rusting for anticorrosive paints' issued by the Sveriges Standardiseringskommission (Sweden).

0.2.3 Assistance was also received from the Indian Railways and Messrs E.R. Joseph & Co, Calcutta.

0.3 Based on the data collected for a period of about two years, this code on corrosion protection of light gauge steel sections for structures has been prepared.

0.4 As degree of protection needed for any particular component is related to the conditions of exposure and the class of steelwork, three different protective schemes have been described in **3** and **4**.

0.5 The protective schemes recommended, if suitably maintained by reapplication of paint are intended to ensure a life of 60 years or more for the light gauge structural members of permanent buildings where the permissible working stress is far more dependent on adequate protection against rusting than is the case for heavier sections. The schemes may also be usefully applied to structures designed for a shorter life where it is desirable to ensure a high recovery value for the steel.

0.6 In the case of aluminium coating, a thickness of $0{\cdot}1\ 778 \pm 0{\cdot}0\ 254$ mm has been specified in this standard based on the exposure tests conducted and taking into consideration the lack of facilities for controlling the thicknesses of aluminium coatings. The Sectional Committee is aware that in many countries this thickness has been specified between $0{\cdot}0\ 762$ to $0{\cdot}1\ 524$ mm. After the proposed long range exposure tests, the thickness now specified will be reviewed.

1. SCOPE

1.1 The recommendations given in this code apply to light gauge components for general building purposes fabricated from mild steel sheet or strip as specified in IS : 1079-1963*.

1.2 The recommendations refer to mild steel reduced by cold rolling and having thickness varying between 2 to 3·2 mm. They are not intended to heavy structural steel work. The recommendations also apply to steel tubes used for construction purposes.

2. GENERAL REQUIREMENTS

2.0 The guiding principles to be followed for the protection against corrosion of light gauge mild steel in building are given in **2.1** to **2.8**.

*Specification for hot rolled carbon steel sheet and strip (*revised*). (Third revision in 1973)

2.1 All such steel parts should receive, before they leave the fabricating works, an adequate protective treatment, for example, application of bitumen paint or a paint primer. The selection of the treatment would depend on the atmospheric conditions prevailing at the site of fabrication, transport and erection. It would also depend on the interval between the fabrication and erection and the type of the subsequent paint coat to be applied.

2.2 Steps should be taken at all stages in storage, transit and erection to avoid damage to the protective coatings.

2.3 Resistance to abrasion and mechanical damage have an important bearing on the choice of protective schemes for steel parts used in building. Damaged areas should be adequately repaired on site, preferably after erection if they are accessible. When adequate precautions cannot be taken to prevent damage, protective schemes should be selected so that local damage will not lead to general failure of the coating.

2.4 The best procedure is to apply the protective scheme to the finished part, that is, after drilling, bending and welding processes have been completed. Overlapping surfaces occurring at riveted joints are best protected before they are assembled and the joint is sealed. The size and shape of the part will have a bearing on the method of protection selected. Special care is necessary when applying certain chemical processes to parts of intricate shape to avoid entrapping processing solutions in the crevices.

2.5 Whatever protective scheme is used, the surface should be dry and clean, that is, free from dirt, grease, loose or heavy scale, or rust, before applying the protective coating. When preparing welded assemblies for painting, care should be taken that the area at or near welds is thoroughly cleaned.

In the case of aluminium coating, a thickness of $0{\cdot}1\ 778 \pm 0{\cdot}0\ 254$ mm has been specified in this standard based on the exposure tests conducted and taking into consideration the lack of facilities for controlling the thicknesses of aluminium coatings. The Committee is aware that in many countries this thickness has been specified between $0{\cdot}0\ 762$ to $0{\cdot}1\ 524$ mm. It is expected that as a result of the long range exposure tests, the thickness now specified will be reviewed.

2.5.1 Detailed recommendations for the preparation of surfaces for painting are given in **4.1.**

2.6 It is essential to envisage each protective scheme as a whole. All treatments, from those given at the fabricators' works to the final protective or decorative finish applied to the parts after installation or erection, should form part of a co-ordinated scheme. For example, if a final coat of air-drying paint is to be applied after erection to parts which have been stove-painted at the works, careful consideration should be given to the selection

of both paints so as to ensure good adhesion. This also applies when selecting paints for repainting.

2.7 The durability of light gauge steelwork exposed to severe conditions of service can only be ensured by maintaining the protective coating. Regular maintenance by painting is, therefore, an essential requirement of the recommendation for this class of steelwork.

2.7.1 Figure 1 (*see* P 13) indicates the various stages of breakdown of a painted surface and the corresponding paint values. Fig. 1A indicates that the whole surface is rusty or discoloured by rust. Fig. 1E indicates that about half of the surface has been affected. Fig. 1K indicates an apparently undamaged surface. On the basis of the degree of rusting it would, therefore, be possible to classify the conditions of a painted surface as Class 1, Fig. 1K; Class 2, Fig 1J; Class 3, Fig 1H, and so on according to the increasing degree of damage suffered by the painted steel work.

2.7.2 Figure 1E illustrates Class 6 of breakdown of a painted steel surface and repainting of light gauge steel structure should not be delayed beyond this stage.

2.8 Based on short term data available on the performance of protective schemes in selected environments in India it is recommended that in the case of protective schemes comprising painting (scheme 3) or phosphating followed by painting (scheme 2), repainting should be done every two years and in the case of aluminium coating followed by painting (scheme 1) repainting may be done after about 5 years.

3. PROTECTIVE SCHEMES

3.1 Scheme 1 — This consists of metallic coating of aluminium followed by painting:

a) *Aluminium Coating* — The surface should be grit blasted to remove sealed rust (No. 40 grade angular particles applied with air pressure of 2-4 kg/cm is recommended). After surface preparation, aluminium (minimum 99·0 percent conforming to IS : 739-1956*) should be applied by using aluminium wire by means of a metallizing gun. Sprayed aluminium should have a thickness of 0·1 778 $\pm$ 0·0 254 mm.

b) *Painting* — Painting will consist of one primer coat of paint conforming to IS : 2074-1962† and two finishing coats of paint conforming to IS : 123-1962‡.

*Specification for wrought aluminium and aluminium alloys wire (for general engineering purposes). (Since revised).

†Specification for ready mixed paint, red oxide-zinc chrome, priming.

‡Specification for ready mixed paint, brushing, finishing, semi-gloss, for general purposes.

3.2 Scheme 2 — This consists of a phosphate coating followed by painting:

a) *Phosphate Coating* — A phosphate coating in accordance with IS : 3618-1966* (Classes B and C).

b) *Painting* — Three coats of paint consisting of one coat of primer (IS : 2074-1962†) and two coats of finishing paints (IS : 123-1962‡) respectively (*see* **4.2** and **4.3**).

3.3 Scheme 3 — This consists of painting with one coat of primer conforming to IS : 2074-1962† and two coats of finishing paint conforming to IS : 123-1962‡.

4. PAINT SYSTEM

4.1 The protection given by painting depends not only on the composition and quality of paints used, but also on the method of application and specially on the method of surface preparation. In general, the effectiveness of a painting scheme is increased when it is applied over a metal coating. Painting of metal coatings is advantageous because it provides marked resistance to mechanical damage to shop coats broken during transit, storage and erection until the final coats of paints are applied. In addition the life of painting scheme over a metal coating is expected to be longer than that over bare steel.

4.2 Correct surface preparation is essential for success with any protective scheme. Most metal coatings will not adhere to steel at all unless the mill-scale is entirely removed. Paint should never be applied to dirty or greasy surface. Where paint is to be applied to bare steel that has rust or carries objectionable scales, a satisfactory surface for painting may be obtained by mechanical methods such as grit or shot blasting or by pickling. Particular care is necessary to adjust the operating conditions properly when blasting heavily rusted steel. Otherwise, the abrasive may drive the rust into the pits instead of removing it from them. Moreover, it is always essential to dust down the surface after blasting by brushing or vacuum-cleaning, or with an air blast.

4.2.1 The paint may be applied directly without special surface pre-treatment to metal spray coatings. Where good adhesion is to be obtained metallic coatings require degreasing followed by surface pre-treatment.

4.3 Total thickness of the dry paint film is an important factor and it is vital that this should be adequate for the purpose in hand. Where circumstances permit, full use should be made of non-destructive thickness

*Specification for phosphate treatment of iron and steel for protection against corrosion.

†Specification for ready mixed paint, red oxide-zinc chrome, priming.

‡Specification for ready mixed paint, brushing, finishing, semi-gloss, for general purposes.

testers to check the thickness of individual coatings and of the complete painting scheme. The thickness of a single coat is affected by the type of paint and by the method of application. But so far as practicable this should be not less than 44-54 g/m² for primer grade and 54-68 g/m² for each coat of finished paint.

4.3.1 Blasting inevitably roughens the surface and due allowance should be made in the painting schedule for the additional paint needed to fill in the depressions.

5. RECOMMENDED SCHEMES OF PROTECTION FOR VARIOUS CONDITIONS OF EXPOSURE

5.1 The recommended schemes of protection for various conditions of exposure are shown in Table 1.

TABLE 1 PROTECTIVE SCHEMES RECOMMENDED FOR LIGHT GAUGE STEEL FOR VARIOUS CONDITIONS OF EXPOSURE

Sl No.	Conditions of Exposure	Protective Scheme Recommended
(1)	(2)	(3)
i)	Fully exposed outdoors under severe conditions, as industrial or sea-board atmospheres	Scheme 1
ii)	Fully exposed outdoors in less severe conditions, as in rural, urban, mildly corrosive marine atmospheres and where severity of corrosion corresponds to indoor conditions	Scheme 1 or 2 according to the estimated severity of the conditions
iii)	Outdoors but sheltered from the weather	Scheme 3
iv)	Exposed indoors to polluted atmospheres where condensation may occur	
v)	Exposed indoors to dry and unpolluted atmospheres	
vi)	Steelwork used indoors for non-structural purposes readily accessible for repainting and replacement and not exposed to severely corrosive conditions	

5.2 Basis of Recommendation — When selecting the appropriate grade of protection attention should be given to the severity of the exposure conditions. The recommendations made for the protection of steelwork used

outdoor are based on the results reported from the outdoor exposure tests carried out at various centres in India and also on considerable experience of the protective scheme in United Kingdom and many other countries, gained both by research and by observations of their behaviour in service.

5.2.1 In decreasing order of severity the types of outdoor exposures may be broadly classified as follows:

a) *Industrial and heavily polluted urban atmospheres* — Conditions adjacent to or within factories of the heavy engineering or chemical industries or buildings in central areas of manufacturing towns.

b) *Marine atmospheres* — The severity of exposure in a marine atmosphere may vary considerably. When steel is subjected to actual wetting by the sea or continuous salt spray as in sea-board conditions for both the rate of corrosion is high; conditions inland in non-industrial districts within a few miles of the coast, although still classified as marine, may be relatively mild.

c) *Urban atmospheres* — Conditions in extensive built-up areas of a residential character or associated only with clean industries not producing atmospheric pollution.

d) *Rural atmospheres* — Conditions in country districts away from large towns and industrial districts and free from usual sources of atmospheric pollution.

5.2.2 A guide to the relative corrosiveness of outdoor atmospheres in various parts of India and of the world for bare steel is given in Table 2.

6. DESIGN AND CONSTRUCTION

6.1 When designing buildings, attention should be given to avoiding features conducive to corrosion since the protective schemes that have been recommended may prove inadequate if associated with poor design, either of the component itself or of the structure as a whole.

6.1.1 Buildings should be designed to avoid internal condensation, which might occur in roof spaces and wall cavities if thermal conditions and ventilation were not carefully controlled. The presence of moisture, which is frequently contaminated by dissolved impurities from the atmosphere, is a major threat to the durability of light gauge steelwork. Wherever possible, use should be made of overhangs, weatherings and flashings made of durable materials to protect the exposed steelwork from the weather. Adequate facilities for draining rainwater from the steelwork should always be provided. Ledges, ridges, crevices and protuberances, such as nuts, bolts and rivet heads, should be avoided so far as possible, or designed to prevent retention

TABLE 2 CORROSION RATES OF MILD STEEL EXPOSED OUTDOORS AT VARIOUS SITES

(*Clause* 5.2.2)

STATION	ATMOSPHERE	CORROSION RATES	
		Outdoor Fully Exposed mm/ year	Indoor (Stevenson's Screen) mm/year
India			
Bombay	Coastal, tropical, hot humid, industrial-cum-marine	0·0 787	0·0 259
Calcutta	Tropical, hot, humid, industrial	0·1 293	0·0 295
Cochin	Coastal, hot, humid, marine	0·0 890	0·0 269
Delhi	Subtropical, humid, urban	0·0 051	—
Jamshedpur	Tropical, industrial	0·0 178	—
Kanpur	Subtropical, humid, semi-industrial	0·0 251	0·0 047
Karaikudi	Tropical, rural, inland	0·0 091	—
Madras:			
30 m from sea	Tropical, marine	0·1 981	—
854 m from sea	do	0·1 341	—
Mandapam Camp:			
410 m from sea	do	0·0 566	0·0 220
46 m from sea	do	0·3 950	0·0 826
Balasore:			
20 m from sea	Marine	0·1 220	—
38 m from sea	Marine	0·0 902	0·0 107
Bhavnagar	Tropical, savana	0·0 127	0·0 038
Tezpur	Humid, subtropical	0·0 422	0·0 178
Other Countries			
Apapa, Nigeria	Tropical, marine	0·0 279	—
Aro, Nigeria	Tropical, inland	0·0 127	—
Basrah	Subtropical, dry	0·0 152	—
Congella, Durban	Marine, industrial	0·1 143	—
Khartoum	Tropical, dry	0·0 025	—
Lagos light house beach	Tropical, surface-beach	0·0 200	—
Llanwetyd wells	Rural	0·0 635	—
Sheffield (University)	Industrial	0·1 143	—

of water. Precautions should be taken to render joint and cover strips watertight by careful sealing. Ingress of moisture from roofing, outside walls, cladding and windows should be prevented. The design of building should, where practicable, admit of easy access to the metal surfaces for repainting.

6.1.2 Certain other factors depending on the location of steelwork should also be borne in mind by the designer since they will have to be taken into account when selecting the protective scheme. For example, light gauge steel, such as metal trim that is in contact with building materials containing chlorides or sulphates, may be exposed to exceptional corrosion risks under damp conditions. In the presence of moisture, gypsum plaster will attack bare steel, and alkaline materials, such as lime mortar and certain cements, will corrode metallic coatings of lead, zinc and aluminium besides being injurious to oil paints. Where such contacts are unavoidable, the application of a thick coat of bituminous paint or mastic asphalt will provide adequate protection for most practical purposes.

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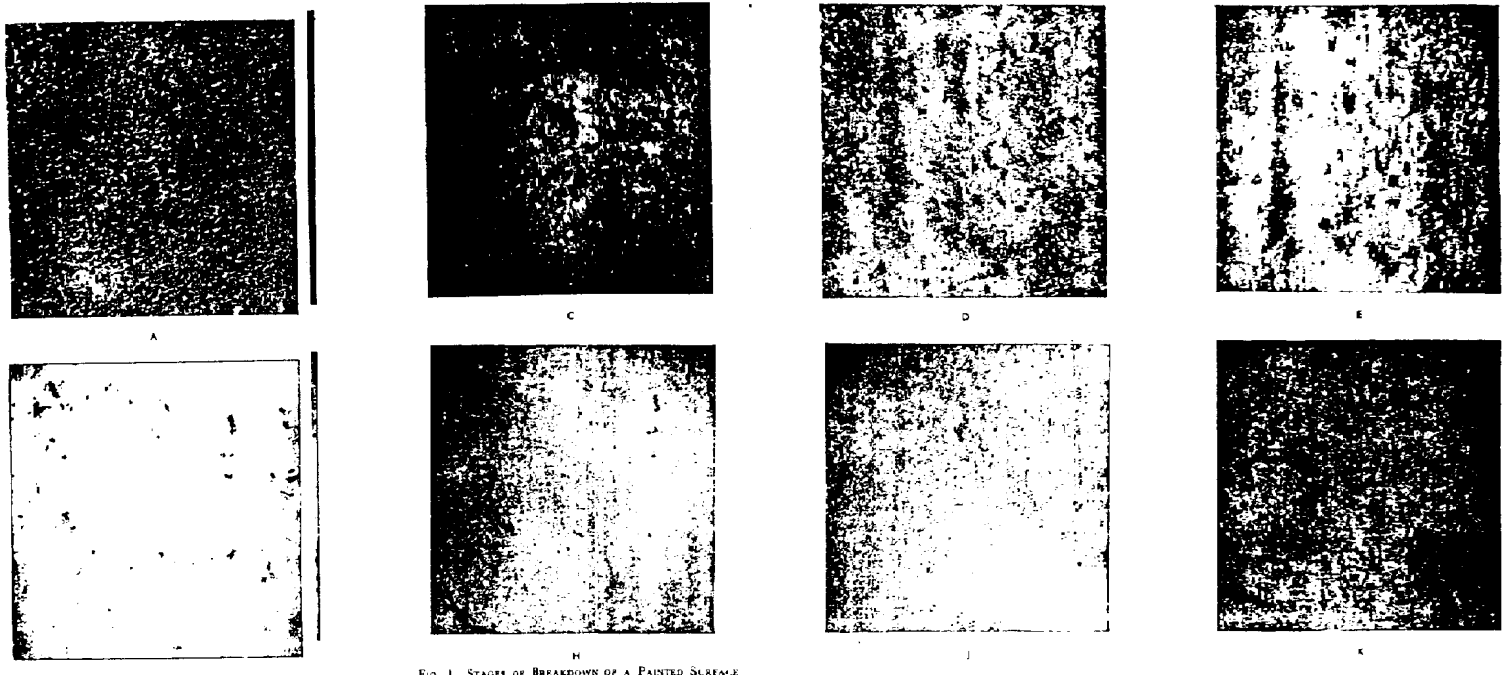

FIG. 1 STAGES OF BREAKDOWN OF A PAINTED SURFACE

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