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GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

Comprehensive Guide *on* Painting for Buildings

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Centre
for
Advanced
Maintenance
TECHnology

Excellence in Maintenance

Maharajpur, GWALIOR - 474 005

Comprehensive Guide
on
Painting for Buildings

Foreword

The Civil Engineering department of Indian Railways maintains a large number of buildings and structures. Painting of these structures is essential to enhance their life as well as from aesthetic considerations. The periodical painting of steel girder bridges is essential to protect them from corrosion and enhance safety of travelling public. However, present practices of painting leave a lot of scope for improvement of quality control in respect of surface preparation, selection of paints and workmanship.

Through this handbook CAMTECH has made an attempt to provide the knowledge about the painting practices including surface preparation, types of paints, painting brushes etc. for masonry works, metal surfaces and wood works along with the defects and their remedial measures. The time-bound maintenance as suggested in this handbook may be adopted for obtaining good quality painting and overcome the ageing or adverse effects of environment.

I hope, this handbook will prove to be a valuable source of technical knowledge and will be quite helpful to civil engineering personnel in Railways.

CAMTECH/Gwalior ***PRAMOD KUMAR***
Date : 27.12 .2007 ***Executive Director***

Preface

Indian Railway is a big organisation having large assets of civil engineering structures and buildings, which need proper care and maintenance during their service life. To enhance the life of structures, the surfaces like plastered, wooden and metallic are painted with the paints of approved brand conforming to the relevant Indian Standards. The contents taken in preparing this book are to meet the requirements of the field personnel who need the proper guidance.

This handbook also provides some informative technical details on *'Painting for Buildings'* for the guidance of civil engineering personnel involved in maintenance of buildings. It covers the various surfaces to make them fit for paint application along with safety measures to be adopted during the painting process.

This handbook does not supersede any existing instructions from Railway Board, RDSO & Zonal Railways and the provisions of IRWM, BIS codes & reports on the subject. *This handbook is not statutory and contents are only for the purpose of guidance.*

We welcome any suggestion from our readers for further improvement.

CAMTECH/Gwalior ***A.K.DADARYA***
Date : 24 .12 .2007 ***Director/Civil***

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ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

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Where "XX" is the serial number of the concerned correction slip (starting from 01 onwards).

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Chapter - 1

General

1.1 Introduction

The painting technology is growing more rapidly day-by-day and it has attained a higher position in almost all areas where nothing is said to be complete without painting as far as material world is concerned. Painting of civil engineering structures is required from aesthetic considerations, and as protective coating. Suitable type of paints applied to the surfaces can enhance the life as well as appearance of the structure.

Almost all types of civil structures are presently in use in Indian Railways, which require safety and maintenance. For this purpose, the surfaces, exterior as well as interior, are protected from various harmful environmental effects by coating them with suitable paints. A coating with dry film thickness (DFT) of about 50 microns is good enough to protect the surface against corrosion, scratches and any other external agents.

The most important functions of paints are protection and decoration of a substrate. The three factors sunlight, moisture and heat affect the durability of paint coatings and the durability of substrates (wood, plastics, etc.). Although, each factor can independently lead to deterioration, the effect of the combination of the three factors is much more severe than each factor separately. Each of them can lead to the breakdown of the resin in painted surfaces which binds (holds) the pigment to the substrate surface. The more resin available to completely coat a pigment particle, the more forcefully the particle is bound to a surface.

It is the fact that premium paints have a high ratio of resin to pigment. A low cost paint typically has a high pigment content relative to resin content as pigment is less expensive than resin. Although a high pigment content paint has an excellent “hiding” ability, high pigment content paints with low resin contents are unable to resist exposure to sunlight and moisture. Gloss paints have more resin than semi-gloss paints, and semi-gloss paints have more resin than flat paints. Gloss paints have the most resistance to ultraviolet radiation and moisture; flat paints have least.

Presently, in India, there are so many companies manufacturing various types of paints under different brand names. The paints covered in this handbook are taken as reference to elaborate the various technical details in case of using them in structures other than bridge structures.

In subsequent chapters, the general guidelines are prepared to facilitate the field personals to carry out the painting work on plastered, metallic and wooden surfaces along with the defects and their remedies, which are covered in detail. Also a list of Indian Standards, which may be useful and referred prior to the painting of surfaces, is given in Annexure-1.

1.2 Terminology

For the purpose of this handbook, the following terms and their definition should be taken into consideration:

Bleeding: The diffusion of coloured material into the upper coat from the under coat is called bleeding, which generally occurs on wooden surfaces. If paint is applied over knots in the wood without properly coating it, the oil in the paint dissolves out substances in the knots that bleed through the paint. The bleeding of paint also occurs when the under-lying paint is not dried properly.

Bittiness: Bittiness is a condition in which small particles project above the surfaces of the film of paint or varnish yielding a rough surface. This may be due to dirty surface, dirty brushes or dirty atmosphere and also due to skin of paint in can being stirred in.

Blooming or Blushing: Blooming is the appearance of a whitish substance on a surface of varnish or enamel. This is accompanied by a loss of gloss and may be caused either by defective composition of paint or varnish, or improper application e.g. during humid conditions.

Blistering: It is the swelling of the paint film generally caused by moisture or volatile substances (presence of oil or grease on the surface) trapped under paint e.g. painting on damp or unseasoned wood, over knots without preparation, on wet ironwork; application of gloss paint over new plaster. It occurs in non-porous coatings such as oil-based paints and enamels.

Bleaching or Saponification: New plastered surfaces are highly alkaline and react with binders used in oil-based paint. This leads to Saponification, which further leads to discoloration (called bleaching due to alkali action), softening and running of paint film. The film tends to become a sticky mass and is easily washed down by water.

Brush Marks: When paint is applied with a brush, bristle marks may appear and in some cases these marks are deep and permanent and further aggregate in a glossy surface. This is generally due to unskilled application, sometimes aggravated by unsuitable paint.

Cracking: It is the chipping of paint film which is due to the cracks developing throughout the entire paint system and extending right down to the original surface. This is often found on exterior work after long exposure. On interior work, this is due to faulty application of paint and insufficient drying between coats.

Chalking: Chalk like substance appears on the painted surface and paint film becomes powder due to insufficient oil in primer (white patches on the surface). This is caused by the effects of sunlight and oxygen in the atmosphere and also by salty air.

Colouring off or Not Matching: This is when the dried paint shade does not match.

Cissing or tiny craters: Cissing is a defect in which a wet paint film recedes from small areas on the surface leaving them apparently uncoated and tiny craters are visible in the centre of hole on the painted surfaces. This occurs due to painting over glossy, oily or waxy surface or lack of preparation of hard and glossy ground.

Dry Spray: Sprayed paint film sometimes dries to a rough gritty finish.

Erosion: Erosion is the weathering away of the top layer of a painted surface. It starts with chalking and ends with the removal of paint film in dry powder form.

Efflorescence: Efflorescence is the appearance of salt-like deposits commonly observed on masonry substrates.

Floatation: During drying, one or more of the pigments separate or float apart from the other and concentrate in streaks or patches on the surface of the film.

Fading/Spotting: The total discoloration and loss of gloss is known as fading.

Feeding or Livering: Paint thickening to a very high viscosity, one which can not be reduced by thinning.

Flaking: Flaking is the detachment of paint film (the breaking of coating system right from the primer to the top finishing coat) from the underlying surface in the form of flakes or scales.

Hiding or Opacity: The ability of a paint film to obliterate the underlying surface is called hiding or opacity.

Holidays or Misses: Holidays represent the patches where paint has not been applied.

Microbial growth: It is in the form of bacteria and fungus growing on the painted surface.

Orange peel: This defect is associated with spray painting. The painted surface will be rough with ups and downs.

Pin holes: The formation of very small holes on the paint film during application and drying. It generally occurs on the applied surfaces.

Patchiness: The uneven finish or scratch like thing appears on the putty-applied surfaces. Presence of foreign matters in the putty leads to this defect.

Pattern Staining: The accumulation of dirt on certain broad surfaces, usually ceilings, appearing as light and dark patterns is called pattern setting.

Poor adhesion: Poor adhesion of paint on the substrate or between different coats of the paint itself can originate.

Peeling: Peeling is the swelling of paint film that is due to located loss of adhesion between one or more coatings or between primer and parent surface and moisture on the surface. It occurs in non-porous coatings such as oil based paints and enamels.

Putty: Putty is a kind of paste prepared for applying on walls to fill in any minor dents or surface imperfections.

Rain-spotting or Cratering: These are minute pits, also called craters, on the surface of a dry film.

Slow drying: This is a defect, which slows down the process of drying the paint film in its required time period.

Setting: Setting is a condition in which the pigments in the paint separate and settle at the bottom of the container.

Sagging/run down/tears: A downward movement of the paint film between the time of application and setting (drying) resulting in an uneven coating having a thick lower edge. This excess paint runs down and gives an uneven surface.

Skinning: Skinning is a term used when the top surface of paint or varnish in a container dries.

Wrinkling: Surface of the paint wrinkles and gathers together when thick coat of paint is applied. The lower portion of the paint does not dry due to greater thickness of the paint film that shrinks due to drying in course of time. It is more pronounced with enamels and varnishes.

Yellowing: It is loss of whiteness, which develops the yellow colour on ageing. This is most noticeable on dried film of white paints or clear varnish.

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Chapter - 2

Painting Masonry Work

2.1 General Considerations

In masonry work, the painting of plastered surfaces is carried out not only for hygienic or aesthetic reasons, but also for water proofing the surfaces and protecting them against natural weathering and chemical attack from industrial atmospheres contaminated with corrosive fumes.

Since the surfaces plastered with lime and cement (calcareous surfaces) are highly alkaline and retain large quantities of water during construction, the special care or treatment should be adopted well before commencing painting work to prevent the surfaces from adverse effects of variable suction, surface imperfections, growth of moulds, mosses, lichens and algae on most of the surface coating materials, finishing.

2.2 Surface Preparation

A successful painting exercise requires adequate planning for painting, which should be started well in advance to take care of occasion like rains, exams, weddings etc. Preparation work like masonry work, crack filling, water proofing etc. should be preferably done before commencing actual painting work. This is also necessary to get the maximum life of the final paint film by doing proper planning for colour scheme and selection of brushes/rollers.

Cement plastered surfaces with new Portland cement concrete and renderings are strongly alkaline, and for this reason solvent based paints when applied to them, are subject to saponification and bleaching. In addition, there is a risk of damage by efflorescence. Solvent based paints should not be used on such surfaces, until several months for drying of the material have passed, but earlier decoration may be carried out with Portland cement paints or silicate paints.

The following precautions with regard to the drying of background should be observed carefully as these will considerably affect the performance of finish.

2.2.1 In case of New Plaster Surface

Surface Dryness: If possible, the plastered surface should be left unpainted for the first few months to allow it to carbonate, harden and dry thoroughly. If not possible to leave the plaster bare, a temporary decoration of soft distemper (non-washable) or a coat of lime may be applied. No attempt should be made to apply solvent based paint (especially gloss finishes) until the plastered surfaces of new brickwork, concrete or building blocks are thoroughly dry.

Cleaning & Treatment: Before painting, the surface should be thoroughly brushed to remove all dirt and remains of loose or powered materials to provide a mechanical key between surface and paint for satisfactory adhesion. Treatment of the surface with solution of acids or salts such as zinc sulphate is not advisable as the risk of alkali attack is not reduced appreciably and efflorescence may be increased.

2.2.2 In case of Old Unpainted Plaster Surface

Surface Dryness: Painting should be deferred until the plaster has dried. Any source of dampness in walls and ceilings should be removed. Any major cracks or defects in the plaster

should be cut out in *V* shape and made good to avoid undue absorption of water and subsequent shrinkage of the filling. Minor repairs may be made with cement mortar. Fine cracks may be primed and subsequently filled with a putty of suitable consistency made out of enamel, water and whiting powder.

Cleaning & Treatment: Any fungus and algae growth must be completely removed by brushing it vigorously with wire brush and by cleaning it with water. If there is an extensive growth of vegetable material which can not be removed by brushing, the growth should be destroyed by applying a wash of *ammoniacal copper solution**. This treatment should be done with greater care on the top of the awnings, sunshades, parapets and other horizontal surfaces where water is likely to accumulate during monsoon.

**A recommended composition and concentration of the ammoniacal wash shall consist of 7 g of copper carbonate dissolved in 80 ml liquor ammonia and diluted to one litre with water.*

2.2.3 In case of previously painted Plaster Surface

Surface Dryness:

- Any existing paint showing excessive flaking, bleaching, or saponification (presence of yellow soapy runs) should be removed by scrapping and washing and the surface allowed to dry completely.
- Dry distempers and lime wash should be totally removed prior to repainting. It may sometimes be necessary to wet the surface before scraping. This should not be overdone and all surfaces should be perfectly dry prior to the application of any priming coats.
- Previously oil painted surfaces should be sanded thoroughly to remove loose particles and made dull and matt for better adhesion.
- Exterior rough surfaces, previously coated with cement paint, should be wire brushed and washed with water thoroughly and allowed drying. Before painting, ensure that the surface is free from chalking.
- The exterior surface should not be affected by any water or by constant dampness.
- In case of painting during the rains, the surface should be allowed to dry out completely for 2-3 days of total sunshine before commencing painting.

Cleaning & Treatment:

- Any existing fungus or mould growth should be completely removed by scrapping and rubbing down the surface thoroughly with bristle brush and sand paper. The surface should be washed down with clean water and allowed to dry. A coat of fungicidal wash should then be applied and allowed to dry after which a further coat should be applied and left for sometime to dry thoroughly.
- Local defective patches should be treated individually by removing all loose or softened paint and bringing forward the treated patches with primer and undercoating before applying a fresh coating over the whole area.
- In case of re-painting, previous coating of lime wash or powder distemper must be thoroughly scrapped off.
- The gloss or sheen of coatings of oil or synthetic emulsion paints; if not in good condition, must be removed by thorough sanding.

Priming Coat:

- Certain wall and ceiling surfaces may reveal hairline cracks. After complete removal of the existing paint systems and if the lime plaster has cured and dried completely, use at least two coats of any of the primers for the paint system to be adopted. When solvent based

paint is to be used, the primer at least shall be of the alkali resistant type. Lime fast pigments shall be used.

- Water based paint or washable distemper, if in a clean, sound condition, need not be removed if similar coatings are to be applied in the new paint system. By using a mild detergent, the surface may be washed and then after a light sanding, will be ready to receive a fresh coat (with spot priming if required).

2.3 Painting Operations

Painting on plastered surfaces should be started only after ensuring that the surface is ready for paint application and there would not be any defect likely to be occurred after drying of the final finish. The painting operations generally include the primer coat, under coat and finishing coat to get the final finish as desired.

First Primer Coat: It is applied to provide adhesion between the paint film and the surface. It smoothens the surface, makes it less absorbent and increases the spreading capacity of the paint.

Application of Putty: This is done to fill the minor cracks and surface imperfections. Drying time for putty is normally 5-6 hrs.

Second Primer Coat: This is applied to sandwich putty between two primer coats, since painting directly on putty leads to a patchy appearance.

Finish Coat: Generally two coats must be applied to get the desired finish and colour. Each coat must be completely dry before the next one is applied. Drying times for different paints vary due to their composition.

2.4 Paint Suitability/ Requirements

Paint being the costly item and also due to its limited shelf life (usually three years as prescribed by some of the paint manufacturers), it is very much essential to plan correct requirement of paint. Usually, one litre paint covers 10 sq. m. area approximately. The general technical data has been given in 2.4.2.

2.4.1 White Wash/ Colour Wash

(a) **White Wash** on both interior and external surfaces with lime fat u/s of approved quality to get the final finish for which one coat of white wash as primer coat and two coats as finishing coat are provided. The actual Coverage may vary from the quoted coverage due to factors such as method and condition of application and surface roughness.

No. of Coat	Approximate Coverage Area	Remark
One	6.0-7.0 sqm/kg	Used as a primer coat
Two	4.0-4.5 sqm/kg	Used as a finishing coat
Three	2.5-3.0 sqm/kg	Used as a finishing coat

(b) **Colour wash** on both interior and external surfaces with lime fat u/s and any approved colour on old/new surfaces to get the final finish for which one coat of colour wash as primer coat and two coats as finishing coat are provided. The actual Coverage may vary from the quoted coverage due to factors such as method and condition of application and surface roughness.

No. of Coat	Approximate Coverage Area	Remark
One	5.0-6.0 sqm/kg	Used as a primer coat
Two	3.0-3.5 sqm/kg	Used as a finishing coat

2.4.2 General Technical Details of Paints

- The information summarized in the table is based on general technical data, which may vary depending upon the types of paints used like Asian Paints, Nerolac Paints, Berger, ICI Dulux, etc.
- Stability of thinned paints is 24 hrs. Within this period, the paints are to be used.
- Actual Coverage may vary from the quoted coverage due to factors such as method and condition of application and surface roughness.

(A) <u>Primers on Interior Masonry Surface</u>

Type of Paint	Approximate Coverage Area	Drying time	Recoating Period for final finish (at 25°C & 50% RH)	Shelf-life	Remark
Water based wall primers	20-25 sqm/ltr/ coat	4-6 hrs.	4-6 hrs.	Three years	Depending on surface and surface preparation
Solvent based primer-Flammable	▪ 18-20 sqm/ltr for one coat ▪ 12-14 sqm/ltr for two coat	-	6-8	Three years	On smooth masonry surface by brushing. **Note:** *May also be used on wood surfaces.*

(B) <u>Interior Wall Surface</u>

Type of Paint	Approximate Coverage Area	Drying time	Recoating Period for finish coat	Shelf-life	Remark
Dry distemper (water based)	▪ 12-14 sqm/ltr for one coat ▪ 6-7 sqm/ltr for two coat	30 min.	4-6 hrs. at 25°C & 50% RH	One year	On smooth interior masonry surface by brushing.
Oil-bound distemper (water based)	▪ 17-19 sqm/kg for one coat ▪ 8-11sqm/kg for two coat	15-30 min.	6 hrs. in case of synthetic & 3-4 hrs. in case of acrylic at 25°C & 50% RH	Three years	On smooth interior primed masonry surface by brushing or spraying.
Emulsion Acrylic Paint (water based)	▪ 25-28 sqm/ltr for one coat ▪ 13-15 sqm/ltr for two coat	10-15 min.	4 hrs. in case of smooth wall finish at 28-30°C & 60-65% RH	Three years	On smooth interior primed masonry surface by brushing.
Emulsion Acrylic Paint (water based)	▪ 26-30 sqm/ltr for one coat ▪ 14-16 sqm/ltr for two coat	15-25 min.	3-4 hrs. in case of 100% acrylic, smooth finish at 28-30°C & 60-65% RH	Three years	On smooth interior primed masonry surface by brushing.
Lustre (solvent based) paint-Flammable	▪ 20-24 sqm/ltr for one coat ▪ 10-14 sqm/ltr for two coat	2-3 hrs.	8 hrs. at 25°C & 50% RH	Three years	On smooth primed masonry surface by brushing followed by rolling.

Matt (solvent based) paint- Flammable	▪ 18-22 sqm/ltr for one coat ▪ 9-12 sqm/ltr for two coat	45 min.	8 hrs. at 25°C & 50% RH	Three years	On smooth primed masonry surface by brushing followed by rolling.
Enamel (water based) paint- semi glossy finish	▪ 12-15 sqm/ltr for one coat ▪ 8-10 sqm/ltr for two coat	20-30 min.	4-6 hrs.	Three years	On smooth primed masonry surface by brushing. **Note:** *May also be used on wood/metal interior surfaces.*

(C) Exterior Wall Surface

Type of Paint	Approximate Coverage Area	Drying time	Recoating Period for finish coat (at 25°C & 50% RH)	Shelf-life	Remark
Emulsion Acrylic Paint (water based)	▪ 10.5-11.5 sqm/ltr for one coat ▪ 5.5-6 sqm/ltr for two coat	30 min.	4-6 hrs. in case of 100% acrylic, smooth finish	Three years	On normal masonry surface by brushing. Not applicable on surfaces subjected to continuous seepage and dampness.
Emulsion Acrylic copolymer Paint (water based)	▪ 6-7 sqm/ltr for one coat ▪ 3-3.5 sqm/ltr for two coat	30 min.	4-6 hrs. in case of acrylic, textured finish	Three years	On normal masonry surface by brushing. Not applicable on surfaces subjected to continuous seepage and dampness
Emulsion Paint (water based)	▪ 10-12 sqm/ltr for one coat ▪ 5-6 sqm/ltr for two coat	30 min.	4 hrs.	Three years	On normal masonry surface by brushing. Not applicable on roof tiles and on surfaces subjected to continuous seepage and dampness
Emulsion Acrylic Paint (water based & water repellent) with anti-algal & anti-fungal properties	▪ 4.5-5.5 sqm/ltr for two coat	1 hr.	6 hrs.	Three years	On normal masonry surface by brushing.

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Chapter - 3

Painting over Metal Surfaces

3.1 General considerations

The use of various metals in almost all industries or productive units is now prominent. On Indian Railways, the steel along with other metals are frequently used and their protection against harmful effects from environment requires the adequate measures. The painting is one which provides protection to metals categorized as ferrous and non-ferrous and requires some necessary information for efficient planning and execution. The necessary information reveals

- the nature of the metal or alloy to be painted.
- the condition of the metal surface and the presence of harmful materials like scale, rust, moisture, greasy dirts, salts, etc.
- the environment in which the paint coating will have to function; and
- the information on the nature of previous finish is desirable for repainting during maintenance.

3.2 Surface preparation

It is most important that any substrate, whether it has been painted previously or not, should be in a fit condition to receive paint. To be ready for painting, a surface should be clean, dry and sound, and it should, as far as possible, also have reached a stable state. Pre-treatment and priming of ferrous and non-ferrous metals under controlled conditions at the factory gives the best results and it is, therefore, advisable to adopt this method whenever possible.

The single most important factor is the correct surface preparation of the metals prior to the painting, as the presence of rust, oil, grease and dirt under the paint film can cause its failure. Therefore, the surface should be clean, dry, free from contaminants and rough enough to ensure adhesion of the paint film. This can be done by any one or a combination of the following methods.

- **Manual hand cleaning:** To remove rust, scale or old coatings with the use of emery paper, wire brushes, scrapers etc for spot cleaning during normal maintenance.
- **Surface washing:** To remove salt deposits and grime with lukewarm water containing 1 to 2% detergent. After that the surface is to be dried, lightly wire brushed and sand papered. This is useful where only the finishing coat of paint shows signs of deterioration and the primary coat of paint is sufficiently in good condition
- **Blast cleaning:** To remove rust, mill scale (oxidization) and old paints with the use of high velocity impact of abrasives (sand & grit). It is the most effective method of surface preparation.
- **Cleaning with power driven tools:** To remove oil, grease, heavy scale / mill scales, rust / residual rust.
- **Flame cleaning:** With the application of an oxy-acetylene flame and then after rust can be removed by wire brushes. However, it should not be done on plates with thickness 10 mm or less.
- **Temporary coatings:** When painting can not immediately follow surface preparation, the temporary coatings will be applied with the use of linseed oil applied uniformly and thinly (one third litre on 10 sqm area) or prefabrication primers.

3.3 Painting operations

The paint application methods commonly used for painting are brushing and spraying. Of these methods, brushing is most economical and versatile method. It is widely used and is suitable for variety of paints. Brush shall not be less than 5 cm in width and should have good flexible bristles. Rags, waste cotton, cloth or similar articles should not be used for applying paint.

The following points should be kept in mind during painting process:

- If a non-elastic finishing coat is applied over an elastic primer coat, it may lead to cracking or 'alligatoring' of the finishing coat.
- If the finishing coat contains a strong solvent, it may attack the primer coat and lead to shriveling (wrinkling) of the entire paint structure.
- It is essential that each coat should be given sufficient drying time before the subsequent coat is applied.
- It is essential to provide a key for subsequent coats in order to improve the inter-coat adhesion by cutting of primer, undercoat and first finish coat
- It is essential for a paint to be applied only after the contents of the drum have been thoroughly mixed.
- Thinners as recommended by manufacturer may be used, if a slight adjustment of viscosity of paints is necessary.

3.3.1 Primer Coats

Primers are applied on steelwork to inhibit corrosion and hence called anti-corrosive primers that may be lead-based or lead-free types. For spray application lead-free primers should be used. The primer coat shall be applied soon after completion of pre-cleaning or pre-treatment in order to prevent contamination of the surfaces in any way. The primer coats on steel should, in preference, always be brushed, as only a brush is capable of 'working in' the paint into the minute depressions on the non-absorbent steel surface thus ensuring a film, free from 'holidays'. Brush application is also stated to give better adhesion.

Two coats should be applied allowing a drying time so that the first coat is quite hand dry before the second coat is applied or according to the manufacturer's instructions. The practice of leaving primer exposed for a long time prior to applying the finishing coats shall be discouraged as the usual two coats application is too thin to give adequate protection for long periods.

3.3.2 Intermediate Coats

3.3.2.1 Filler coats

a) Filler coats are applied to fill deep dents and to obtain a smooth finish wherever necessary. Only factory prepared filler suitable for steelwork shall be used. Fillers prepared by whiting and linseed oil by craftsmen at site shall never be used as such fillers may be unbalanced and incompatible with the primer, undercoating and finishing coats.
b) Correct application of filler requires a good putty knife and skilled workman who obtains good results by experience. The filler should be applied in thin layers and be sufficient to fill the depression or unevenness. The hardened filler surface should be cut down by wet rubbing before the subsequent coat is applied. Where necessary, filler coats may be applied over the undercoats also.
c) Ready-mixed filler by brushing or spraying is recommended to fill up surface scratches or similar fine dents all over the surface.

3.3.2.2 Undercoating

The purpose of applying a coat of undercoating after application of primer is to provide a smooth and level foundation for the finishing coat, hide the primer/filler coats and give a full bodied colour in conjunction with the finishing coat. Undercoating may be applied by brush or spray. After the film of undercoating is hard dry, wet rub to a smooth finish before the first coat of finishing is applied.

3.3.3 Finishing Coats

This is the coat which comes in direct contact with the weather and has to protect the underlying coats, which in turn protect the painted surface. Finishing paints/enamels confirming to the relevant Indian Standard specifications shall be employed. Normally two finishing coats are recommended and may be applied by brush or spray. The second coat may be applied after the first coat is hard dry and its gloss is knocked off by scuffing with a very fine cutting device.

3.4 Paint suitability/ requirement

The application of paint film has two main purposes. The first one is to protect the steel from corrosion and the second for decorative appearance. A paint film comprises of coats of primer, filler, undercoating and finishing paints. For satisfactory performance of a paint film, under the conditions in which they are required to perform, selection of the right type of paints and their adjuncts is of utmost importance. For paints to perform satisfactorily, the paint manufactures may be consulted. As a general rule, it is safer to use primer, filler, undercoating and finishing paints made by the same manufacturer. The general technical data has been given in 3.4.1.

3.4.1 General Technical Details of Paints

- The information summarized in the table is based on general technical data, which may vary depending upon the types of paints used like Asian Paints, Nerolac Paints, Berger, ICI Dulux, etc.
- Stability of thinned paints is 24 hrs. Within this period, the paints are to be used.
- Actual Coverage may vary from the quoted coverage due to factors such as method and condition of application and surface roughness.

(A) <u>Primers on Ferrous Metal Substrate</u>

Type of Paint	Approximate Coverage Area	Drying time	Recoating Period for final finish (at 25°C & 50% RH) (hrs.)	Shelf-life	Remark
Red oxide primer	14-16 sqm/ltr/ coat at 25 micron DFT	6-8 hrs.	6-8	One and half years	Depending on surface and surface preparation

(B) Paints on Interior Metal Surface

Type of Paint	Approximate Coverage Area	Drying time	Recoating Period for final finish (at 25°C & 50% RH)	Shelf-life	Remark
Enamel (solvent based) paint-Flammable	▪ 13-16 sqm/ltr for one coat ▪ 7-9 sqm/ltr for two coat	3 hrs.	6-8 hrs.	Three years	On smooth primed mild steel surface by brushing.
Enamel (solvent based) paint-glossy finish	▪ 18-24 sqm/ltr for one coat ▪ 10-12 sqm/ltr for two coat	3 hrs.	8 hrs.	Three years	On smooth primed mild steel surface by brushing.

Note: *May also be used on wood/wall interior surfaces*

(C) Paints on Interior and Exterior Metal Surfaces

Type of Paint	Approximate Coverage Area	Drying time	Recoating Period for final finish (at 25°C & 50% RH)	Shelf-life!	Remark
Enamel (solvent based) paint-Flammable	▪ 18-24 sqm/ltr for one coat ▪ 10-12 sqm/ltr for two coat	3 hrs.	8 hrs.	Three years	On smooth primed mild steel surface by brushing.
Enamel (solvent based) paint-Flammable	▪ 18-22 sqm/ltr for one coat ▪ 10-12 sqm/ltr for two coat	2.5 hrs.	6-8 hrs.	Three years	On smooth primed mild steel surface by brushing.
Enamel (solvent based) paint-Flammable	▪ 16-22 sqm/ltr for one coat ▪ 9-11 sqm/ltr for two coat	3 hrs.	6-8 hrs.	Three years	On smooth primed mild steel surface by brushing.

Note: *May also be used on wood/wall interior/exterior surfaces*

3.4.2 Present Practice of Painting of Bridges in Indian Railways

A) ***Protective coatings by painting:*** The following system of paints may be adopted for painting of steel bridges:

For locations where corrosion is not severe

i) *Primer coat*

- One heavy coat of ready mixed paint red lead primer to IS:102-1962 *(*9-10 sqm/ltr per coat)* or

- One coat of ready mixed paint zinc chromate primer to IS:104-1979 *(*11-13 sqm/ltr per coat)*, followed by one coat of ready mixed paint red oxide zinc chrome primer to IS:2074-1992 *(*11-13 sqm/ltr per coat)*

ii) *Finishing coat*: Two finishing coats of red oxide paint to IS-123 *(*14-15 sqm/ltr per coat).*

For locations where corrosion is severe

To avoid frequent painting, metallising or epoxy painting for existing girders is recommended but when there are no facilities available for the same, protective coating by oil painting with following painting scheme should be applied.

i) *Primer coat*

- Two coats of ready mixed paint red lead priming to IS:102-1962*(*9-10 sqm/ltr per coat)* or
- One coat of ready mixed paint zinc chrome primimg to IS:104-1979 *(*11-13 sqm/ltr per coat)*, followed by one coat of zinc chrome red oxide primimg to IS:2074-1992*(*11-13 sqm/ltr per coat)*.

ii) *Finishing coat:* Two coats of aluminium paint to IS:2339-1963 *(*20-21 sqm/ltr per coat).*

Note:

1. *One type i.e. Red lead (IS:102) as base coat and Aluminium (IS:2339) as finish coat (two coats) is more durable and has longer life.*
*2. * denotes as 'Actual Coverage may vary from the quoted coverage due to factors such as method and condition of application and surface roughness'.*

B) ***Metallising:*** This is a form of protection by spraying a metal either Zinc or Aluminum. Protective coating by metallising with sprayed aluminium to 150 micron thickness is to be provided as given in the Appendix VI of IRS-B 1-2001 followed by oil painting over metallised component as per schedule given below:

Stage of painting	Procedure	Description
Finishing coat	1. Washing by thinner	After the Metallising, any oil, grease etc. should be removed by thorough wash with a suitable thinner and allowed to dry for 15 minutes.
	2. First coat	One coat of etch primer to IS 5666 - 1970
	3. Second coat	One coat of zinc chrome primer to IS 104 – 1979
	4.Third coat	Two coats of aluminium paint to IS 2339 - 1963

Note: *Metallising protection will be more effective and economical if carried out in workshop during fabrication of new girders. Site metallising is not found effective as per the experience gained in the past and hence it should be planned during fabrication in workshop and metallised components handled properly during loading, unloading, while transporting from workshop to site and erection at site. Life of metallising if done in workshop with sand/grit blasting and touching up of cover aluminium oil paint whenever required will be 25 to 30 years.*

C) ***Use of epoxy based paints*****:** Epoxy based paints have good adhesion and abrasion power and can be used in lieu of metallising in the field for existing girders. Real benefit of epoxy painting can be achieved with longer life of paint than frequent oil painting which is more costly for maintenance of steel girders on existing bridges. Life of epoxy painting is 12 to 15 years if correct epoxy scheme is selected.

a. Surface Preparation

i) Remove oil/grease from metal surface by using petroleum hydro-carbon solvent to IS: 1745.
ii) Prepare the surface by sand or grit blasting or wire brushes operated by pneumatic power or electricity to near white metallic surface.

b. Epoxy Painting

Stage of painting	Procedure	Description	Remark
Painting	1. Primer coat	Apply by brush/airless spray two coats of epoxy zinc phosphate primer to RDSO specification No. M&C/PCN-102/86	60 microns minimum thickness (DFT) giving sufficient time gap between two coats to enable first coat of primer to hard dry.
	2. Intermediate coat	Apply by brush/airless spray one coat of epoxy micaceous iron oxide paint to RDSO specification No. M&C/PCN-103/86	100 microns thickness (DFT) and allow it to hard dry.
	3. Finishing coat	a) For coastal locations- Apply by brush/airless spray two coats of polyurethane aluminium finishing to RDSO specification No. M&C/PCN -110/ 88 b) For other locations, polyurethane red oxide (Red oxide to ISC 446 as per IS:5) to RDSO specification No. M&C/ PCN-109/88.	a) 40 microns minimum thickness (DFT) giving sufficient time gap between two coats to enable the first coat to hard dry. b) The finishing coats to be applied in shop & touched after erection, if necessary.

3.4.3 Periodical through Painting

The entire steel work of a girder should be painted at regular intervals which may vary from six years in arid zones to one year in highly corrosive areas. The chief Engineer shall prescribe the periodicity of painting. Floor system of girders etc. where corrosion is heavy, may require painting more frequently. Their periodicity should be as specified by the chief Engineer.

3.4.4 Shelf Life of some of the Paints used in Indian Railways

Paints should be used within the prescribed shelf life from the date of manufacture. The shelf life of various paints used in the Railways are as under:

i)	Paint red lead ready mixed (IS: 102)	–	4 months.
ii)	Paint red oxide ready mixed (IS: 123)	–	1 year.
iii)	Paint aluminum		
	When paste and oil are not mixed	–	1 year.
	When paste and oil are mixed	–	4 months.
iv)	Oil linseed boiled	–	2 years.
v)	Red lead dry paint	–	(No time limit)

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Chapter - 4

Painting over Wood Surfaces

4.1 General considerations

In almost all civil structures or buildings, the wood is extensively used as a building material for various purposes and easily available in nature. The wood surface is liable to deterioration from a number of causes amongst which are fungi, insects, and marine bores. No timber is known to be absolutely immune from attack although a few (such as teak) are highly resistant. Timber in a dry and well ventilated place or continuously submerged under fresh water will last indefinitely.

The main objective of applying paints to wooden surfaces is to provide a smooth protective cover of the desired colour, with improved aesthetic appearance of wood structure. The good quality painting makes the woodwork:

- more durable
- more decorative with smooth finish, and
- free from bacterial and fungus formation, which are unhygienic and gives ugly look.

Different types of paints are available in the market for providing opaque coating. However, *enamel paints* are widely used due to their superior surface finish and durability.

4.2 Wood surfaces

Exposure to sunlight (ultraviolet radiation), moisture and heat are the major factors affecting the durability of paint coatings and the durability of substrates (wood, plastics, etc.). Although, each factor can independently lead to deterioration, the effect of the combination of the three factors is much more severe than each factor separately. When the resin breaks down, pigment is lost (washed away from the surface) and fading occurs. In some instances, rubbing the surface with a cloth or a hand will remove a white powder from the paint surface (chalking).

Exposure of unprotected wood to sunlight can adversely affect the adhesion of paint to wood within as little as 3 to 4 week exposures. Wood surfaces should be painted as soon as possible, weather permitting. Top coats should be applied within 2 weeks of field exposure of the prime coat.

4.3 Surface preparation

Wood absorbs moisture so that it must be treated well before application of paint. The wooden surfaces should be inspected for insects and fungus that are generally found in woods which are soft and porous in nature. It must be checked that any defects likely to be occurred during surface preparation should be rectified well before commencing the painting work.

The process of making the surface fit for paint application, in which the surface is made smooth, free of surface imperfections and thoroughly clean of all dust & dirt.

4.3.1 For new wood surface, the wood should be well seasoned, dried, and cleaned of scales, smoke and grease and the entire surface shall be sandpapered along the grains to make it smooth. ***Knots*** excreting resin in the wood and causing cracking, peeling and brown discoloration shall be treated properly by:

Lime knotting: Apply a coat of hot lime and scrape it after 24 hours. Then apply primer of red lead and hot glue with one coat of knotting varnish. Suitable for Deodar and other resinous wood. **Or**

Ordinary size knotting*:* Apply first primer coat of red lead and hot glue, on drying followed by second coat of red lead grounded in oil and thinned with boiled oil and turpentine. **Or**

Patent knotting: Apply two coats of varnish consisting of 250 gms. pure shellac, 1.0 litre methylated spirit and 25 gms. red lead.

4.3.2 For old wood surface, *if the old paint is sound and firm* and its removal is considered unnecessary, the surface shall be rubbed down with sandpaper to remove all dust and loose paint after it has been cleaned of all smoke and grease. If required, grease shall be removed by washing with lime/washing soda and rinsing with water. *If the old surface is blistered or flaked badly,* it should be removed completely with sharp glass piece/stripping knife, sand paper and by use of either:

Patent paint remover: Remover solution is applied with brush and when the paint film lifts and wrinkles, it is scrapped thoroughly. After removal of paint, surface shall be washed down with turpentine. **Or**

Caustic soda solution: (1 part soda + 48 parts water) this is applied with brush and when the paint film lifts and wrinkles, it is scrapped thoroughly. After removal, surface should be rinsed with several change of clean water with little acetic acid/vinegar in final rounds of rinsing. **Or**

Blowlamp: Flame is moved over the paint coating just enough to soften it without charring the paint and/or background. The softened paint is removed completely with scrapping knife/glass piece. Burning off shall be carried out from bottom to upward on vertical surface. Blowlamp shall not be used on narrow/carved/undercut surfaces or where there is a risk of damage to adjoining material.

Note:

- *Any surface imperfection must be rectified by applying wood filler by putty knife or by muslin cloth pad in a circular motion with sufficient pressure to force the filler into the pores. The excess filler must be removed by strokes along the grain pattern.*
- *Allow 2-3 hours drying time before sanding and applying subsequent coats of wood filler.*

4.4 Painting operations

4.4.1 Primer Coating: Applied to fill the pores of wood & to provide adhesion between the paint film and the surface. It smoothes the surface, makes it less absorbent and increases the spreading capacity of the paint. It shall have no turpentine as it impairs the firmness of paint.

Primer shall be either prepared at site or readymade paint of approved brand/manufacturer shall be used.

- **First primer coat:** After surface preparation and thorough drying of wood, 1st primer coat shall be applied.
- **Stopping & filling:** After the priming coat is applied, the holes and indentations on the surface shall be stopped with glazier's putty (1 part white lead + 3 part fine powdered chalk + boiled linseed oil to form stiff paste) or ready made putty of reputed brand. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in the stopping and the latter is, therefore liable to crack.
- **Second primer coat:** This is applied to sandwich putty between two primer coats, since painting directly on putty leads to a patchy appearance.

4.4.2 Application of Final Paint

Preparation of Mix

Ready made enamel paint of reputed brand confirming to IS Specification, of desired colour/shade shall only be used. Paint as supplied shall be used for painting. If required, thinning can be done with mineral turpentine oil to the extent as recommended by manufacturer (max. 5-10%).

Paint coats

Generally one coat should be adequate for old work and two coats (excluding priming coat) for new work to get the desired finish and colour. In case the earlier paint shade is significantly darker than the new shade, an additional coat of paint is recommended.

Process of Paint application

- Paint application shall be carried out with proper painting brush. Paint shall be applied evenly and smoothly by means of crossing and laying off, the latter in the direction of the grain of wood. The crossing and laying off consists of covering the area with paint, brushing the surface hard and then brushing alternately in opposite directions, two or three times and **finally brushing lightly in a direction at right angles to the grains**. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

- The subsequent coats shall be applied only after the previous coat has dried. Before application of next coat, previous coat shall be lightly rubbed down with sandpaper and dust shall be cleaned. The finish surface shall be even and uniform and shall have no brush marks.

4.5 Paint suitability/ requirement

Mixed pigment paint provides better protection; white lead combined with zinc oxide and a moderate amount of filler such as barytes or silica gives good results. Tinted paints have proved to be satisfactory for maintaining colour and durability. Generally enamel paints are used to give high gloss surface. When the wood is of superior quality and if the grains are to be highlighted the only choice is the varnish forming a transparent or translucent film.

4.5.1 General Technical Details of Paints

- The information summarized in the table is based on general technical data, which may vary depending upon the types of paints used like Asian Paints, Nerolac Paints, Berger, ICI Dulux, etc.

- Stability of thinned paints is 24 hrs. Within this period, the paints are to be used.

- Actual Coverage may vary from the quoted coverage due to factors such as method and condition of application and surface roughness.

Type of Paint	Approximate Coverage Area	Drying time	Recoating Period for final finish (at 30°C & 75% RH)	Shelf-life	Remark
Wood finish (melamine) solvent based paint- Flammable	8-10 sqm/ltr/ coat	20 min. & tack free time- 2 hrs.	8-10 hrs. by brushing and 5-6 hrs. by spraying	One year	On smooth sanded wooden surface by spraying. Drying time 8 hrs.
Wood finish (Touchwood) solvent based paint- Flammable	9-11 sqm/ltr/ coat	1 hr. & tack free time- 4 hrs.	24 hrs.	Three year	On smooth sanded wooden surface by brushing.

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Chapter - 5

Defects and their Remedies

5.1 Defects with their remedial measures

The success of painting depends on defects free painting. However, due to various reasons like faulty workmanship, defective paint and poor surface preparation may lead to various kinds of defects.

The major types of defects with their possible causes and remedies are as follow:

Defects	Causes	Remedies
Bittiness	• Dirt from atmosphere on the surface or from brushes that are inadequately cleaned. • Due to bits of dried up part that gets stirred in. • Using paints without straining. • Applying paint to dust laden areas. • Using dirty equipment and utensils. • Applying gloss paint over old paint without using an under coat.	• Use clean brushes and paints on clean surface. • Strain the paint through a cloth before use. • Rub the surfaces with sandpaper, removing all loose particles and dust. • Apply the paint in a dust-free atmosphere.
Bleaching or Saponifi-cation	Due to alkali reaction with the binders used in oil-based paint.	• The best preventive measure is to allow the plaster to cure after the recommended coat of lime wash is applied. • For a new painting job, the surface should be primed with an alkali-resistant primer. • For an old plastered surface, completely remove the affected area by washing with water and then soft paint should be removed by scrapping. Allow the surface to dry completely and apply alkali-resisting primer before repainting.
Bleeding	• Wooden surface defects (knots). • Previously applied coat not dried properly. • Irregular shape/geometry of the object to be painted. • Poor surface preparation. • Using powerful solvents over a normal dried paint film.	• Knots to be properly covered with two coats of shellac varnish/gold size. • Ensure proper drying time in between two coats of paints. • Prepare well the surface to be painted. • Preferably keep the painted jobs in vertical position during drying. • The insulating coat must be applied to withstand the solvents of the finish coat that are able to pickup bituminous or other deleterious matters.

Blistering	Trapped moisture or gases in paint film (more likely in enamels). ***Prevention:*** *Sand the surface smooth and then repaint it.*	• Emulsion paints provide a porous coating and allow moisture to pass through. • Allow surface to be fully dry before painting. • Avoid painting under direct sunlight.
Blooming or blushing	• Applying of paint under high humidity. • Condensation of water on a paint film that has not dried. • The use of improper thinner. • Applying of paint in a poorly ventilated room.	• Clean the affected area. • Repaint avoiding bloom activating conditions particularly a moist or fume-laden atmosphere.
Brush Marks	• Applying paint using poor quality brushes or new/coarse brush for finishing coat. • Flatting operation not done properly. • Paint is too thick i.e. high viscosity. • Poor workmanship (Careless application). • Using quick drying paint by brush. ***Prevention:*** *Use proper brushes and thin paint to desired proportion.*	• Sand surfaces to a smooth finish and apply paint. • Using correct viscosity of paint. • Use good quality brushes. • Wet flattening operation in between two coats.
Chalking	• Applying paint over oily, greasy or very smooth surface. • Combination of unsuitable pigment. • Applying paint over loose particles like dust or rust. • By not sanding previous coat of gloss paint. • Inclusion of foreign particles in the paint. • Applying paint over partially dried coat. • Paint not mixed properly. ***Prevention:*** *Employ proper surface preparation.*	• Use approved quality paint. • Mix well before using paint. • Store paint in dust free atmosphere. • Filter the paint before used. • Surface should be re-painted.
Cissing or tiny craters	• Small impurities in paint. • Oily or greasy surface. • Water based paints being applied over glossy or smooth enamel paints. ***Prevention:*** *Clean surfaces prior to sanding and remove all sanding dust.*	• Clean the surface thoroughly with soap solution and water. • Roughen enamel paint with sandpaper or use a barrier coat of matt primer. • Remove paint completely from affected areas and repaint.
Colouring off or Not Matching	• Paint not thoroughly stirred. • Paint not properly applied. • Applying a very thin coat. • Wrong-coloured undercoat.	Apply finish paint after taking into account the causes for colouring off.
Cracking	• Due to the excessive use of putty or very thick coat of paint. • Due to a defective surface. • Cracks in the plaster or masonry do not let the paint to remain intact. • Paint applied on glossy surface. • Applying the finish coat before the under coat has not completely dried out. • Painting improperly seasoned wood.	• Regulate use of putty and paint. • The defective coat or coats must be completely removed. • Exposed base should be then rubbed down to a smooth face and primed before re-painting. • When cracks are very smell and do not enlarge with time, the top coating is flattened with emery paper and a fresh coat of paint is applied.

Dry Spray	• High air pressure • The gun moved too fast across the surface. • The paint too thin to form a continuous film. • The gun kept far from the surface.	Sand the surface thoroughly and apply paint under recommended application procedure.
Efflorescence	• Due to the presence of water in substrate. • Accumulations of crystalline powder on the underside of the paint film ultimately resulting in paint breakdown, if the substrate is coated with an impervious coating like Synthetic Enamels. • In the case of porous films like emulsion paints, the salt solution can pass through the film, crystallising on the paint film. It can be brushed off the film without any harm.	• Allowing the plaster to dry completely before taking up a painting job. • Any subsequent leakage in the plaster has to be properly attended.
Erosion	Due to long exposure to the weather.	The weathered paint has to be removed completely and the surface repainted with a suitable paint.
Fading/ spotting	• Improper paint formulation. • Pigment not properly mixed. • Use of incompatible pigment. • Paint not mixed well before application.	• Use good quality of paint. • Mix paint well before application. • Good surface preparation. • Good workmanship.
Feeding or Livering	• Mixing incompatible materials. • Materials stored for longer than their shelf life. • Use of the wrong thinner. ***Note:*** *Most paints and varnishes affected by thickening can not be reconditioned, particularly those which have thickened or solidified due to a chemical reaction.*	
Flaking	• The moisture penetration through cracks on the coatings resulting in the loss of bond between surface and paint film. • Poor surface preparation. • Residue left after cleaning with solvent. • Paint with poor flexibility and adhesion. • Paint film is not having elasticity. • Due to expansion and contraction of metal panels during change in temperature.	• Use of plastic emulsion paints. • Ensure proper surface preparation before painting. • Surface should be rubbed with emery paper before applying a fresh coat. • Use of paint with good elastic, flexibility properly. • Neutralising the surface after solvent cleaning. • All dirt and dust on surface to be removed prior to painting.
Floatation	• The use of the wrong type of thinner. • Excessive thinning of the paint.	Stir the paints thoroughly and apply after removing the previous coat.
Hiding or Opacity	• Excessive thinning of the paint. • Improper application. • An uneven or highly absorbent surface. • A very thin coat of paint. • Paint not stirred thoroughly.	Surface preparation and paint preparation should be proper before commencing the painting work.
Holidays or Misses	• Careless application of paint. • Working under artificial or inadequate light. • The colour of the under coat being too close to the colour of the finish coat.	• Apply paint on the places missed. • Try not to make the surface look patchy.

Loss of gloss	• Due to poor surface preparation. • Due to presence of oil or grease. • Due to over thinning of paint. • Using thinners that are not recommended. • Applying enamels over highly absorbent substrates. • Not allowing the previous coat to dry. • Storing in a chamber without proper exhaust. • Presence of moisture in the atmosphere.	• Sand the surfaces and apply a finish coat with the necessary precautions. • Clean surface thoroughly and take all recommended steps for surface preparation.
Low-coverage	• Improper thinning and application. • Highly absorbent surface. • Rough texture of plaster. • Direct application over putty.	• Proper thinning before application of paint. • Surface preparation to be adequate before applying paint.
Microbial growth	• Painting over a surface affected with microbial growth. • Seepage or dampness in buildings. • Contamination of paint from materials used in putty preparation i.e. whiting, glue and water. ***Prevention:*** • *Before painting, the affected area should be cleaned with bleach (2% solution) or a recommended bio-wash.* • *Use clear water for thinning and putty preparation.* • *Keep doors and windows open during and after painting.*	Cleaning with bleach solution or bio-wash and repainting the surface with a fresh coat of paint can treat post microbial growth. ***Note:*** *This method is not foolproof and microbial growth can recur under favourable conditions.*
Orange peel	• Applying paint that is too viscous. • Faulty atomisation of paint while spraying. • Spraying too close to the object or holding the gun too far away from the surface being painted. • Water gets mixed up with the paint while spraying. • Defective spray gun. • Low air pressure. • Fast drying thinner is used. • Due to 'bounce back' effect. ***Prevention:*** *Sufficient drying time between coats.*	• Rub out orange peel and repaint. • Spraying done at spray booth. • Use correct air pressure. • Maintain correct distance between object and spray tip (one foot). • Use filter for separating moisture from air. • Use recommended thinner with correct viscosity of paint. • Good workmanship. • Good spray gun and other equipment.
Poor adhesion	• Applying paint over oily, greasy or very smooth surface. • Applying over loose particles like dust or rust. • Employing improper pre-treatment or surface preparation. • By not sanding previous coat of gloss paint. • Applying over partially dried coat. ***Prevention:*** *Employ proper surface preparation.*	Surface should be re-painted taking into account the above factors.

Patchiness	• Due to highly absorbent nature of surface. • Application to finish coat over spot puttied surfaces. • High alkalinity of surface (evident in new walls). • In complete drying of filler or putty. • Application of thick coat of putty, which gives patchiness on subsequent drying. ***Prevention:*** • *Allow new walls to get cured for atleast three months.* • *Apply thin coats of putty.* • *Always apply a primer coat after applying spot putty.* • *Always sandwich coats of putty with primer.* • *Cracks in plaster should be filled with cement sand mixture instead of oil putty.*	• Apply an extra coat of primer or use well sealer. • Scrape the surface and repaint adopting the right surface preparation.
Pattern Staining	• It is caused by heat rising in the room, as well as dust. As the warm air penetrates through the colder surfaces of the ceiling and passes through, it deposits dust particles upon the surface. Because the transference of heat takes place to a greater degree at the coldest areas on ceilings where the joints are of wood (a poor heat conductor), the plastered areas between them become darker. If the joints are of steel, the areas directly under them grow darker than the areas between. • Pattern staining occurs on both porous and impervious surfaces.	• Use a water solution of soft soap or detergent to remove atmospheric pollution on the paint surface. • In general, flat paint retains a stronger grip upon dirt than gloss paints, but gloss paints are able to withstand stronger washing solutions than flat paints.
Peeling	• Due to moist air, oily or greasy surface, or imprisoned gases between the painted surface and the paint film, which expand under the influence of heat. • Poor adhesive quality of paint. • Too much varnish in the paint. • Paint applied on wet condition. • Flatting operation not done properly between two coats.	• Emulsion paints provide a porous coating and allow the moisture to pass through. • Use of approved quality of paint. • Good surface preparation, wet flatting in between two coats. • Mix paint well before application. • Ensure moisture free surface before painting. • Use correct quality of varnish in paint.
Pin holes	• Painting over surfaces contaminated with grease or oil. • Moisture present in the coating system. • Too quick application of putty. • Carrying out further operation before hard dry. • Presence of dust also causes pinholes. • Dent is too much. • Improper atomisation while spraying. • The top surface dries quickly when compared to the inner surface, which causes pinholes.	• Ensure that water/moisture does not get trapped in the putty. • Build up dents with putty stage by stage. • Carryout painting only when surface is hard dry. • Ensure that proper atomisation takes place while spraying. • Protect paint and do painting in dust free atmosphere.

Rain-spotting or Cratering	Due to rain falling on the surface of wet paint.	• The surface must be rubbed down to eliminate the marks, using suitable abrasives to a smooth surface. • Repaint under suitable weather conditions.
Sagging/ Run-down/ Tears	• Too much of paint applied (Excessive thick coat). • Spraying too close or at a high pressure. • Nature and shape of the object to be coated. • Poor workmanship. • Poor surface preparation (at certain location). • Viscosity of the paint is less (paint too thin), or by using a wrong thinner. ***Prevention:*** *Apply finish-coat using recommended thinner.*	• Sand surface to smooth the sagged areas and repaint. • Care must be taken while brushing to see that any paint carried away with brush must be squeezed out in the container. • Use correct viscosity paint. • After completing the painting, check up the area that is likely to sag. • Maintain specified distance between spray gun and the job. (generally one foot) • Avoid the painted objects kept in vertical position during drying. • Spread paint finally with vertical strokes.
Setting	It is caused mainly by the difference in specific gravity of the pigment and the medium.	• Stir the contents thoroughly to a homogeneous paste before use. • Invert the containers periodically to prevent excess setting.
Skinning	• Due to high voltage in the container filled with paint. • The container is kept open to allow air in.	• Paint that has skinned can be made fit for use by removing the skin. • It is advisable to use the skinned paint after straining it through muslin or a nylon cloth.
Slow drying	• Due to unfavourable atmospheric conditions. • Due to the use of a wrong thinner. • Due to mixing paints or the addition of large quantities of universal strainers. • Due to the existence of grease and wax causing non-drying. ***Prevention:*** *Sand the tacky surface thoroughly to remove the existing paint.*	• Good light, proper ventilation and a warm atmosphere accelerate the drying process of paint. • Application of paint at high temperatures will lead to faster drying and affect ease of application.
Wrinkling	• Poor workmanship. • Poor adhesive property of paint. • It may appear when a coat of paint is applied on a greasy surface. • Due to application of very thick coating. • The difference between inner layer and outer layer coating. • Presence of heavy pigments. • The exposure of the wet film to rapid drying conditions.	• Care must be exercised while brushing. • Ensure proper surface preparation before painting. • Use only recommended viscosity of paint. • Use paint with good adhesive property. • Use curing agents for drying.

Yellowing	• Paint film is excluded from natural sunlight. • Paint film subjected to too much sunlight. ***Prevention:*** • *Use anti-yellowing water based enamel.* • *Improved daylight and ventilation for inside work.*	Surface should be cleaned and re-painted.

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Chapter - 6

Painter's Work & Related Safety Measures

6.1 General

A painter employed in this trade should be aware with the process to paint different surfaces. The painting process includes

- Inspection of surface (ready to receive the paint)
- Cleaning of surface
- Application of Primer (thinning, if required)
- Application of Putty
- Application of Final Paint

Painting is the job which should be done by the person who has been trained and has the basic knowledge about the paints, surfaces to be painted and various tools and machinery employed during painting operations. There are certain tools and equipments, which are frequently used during painting process.

6.2 Precautions to be taken by Painter

- Check wood surface for all nail holes, cracks and other defects properly filled and smoothened before application of primer. Nails shall be punched well below the surface and the holes shall be filled with wood filler.
- Do not use very old paint. Normally shelf life of paints is 3 years in original tightly closed containers kept away from direct sunlight and excessive heat.
- Normally 5-10 cm wide brushes are used.
- Paints and solvents (highly inflammable) should be kept away from reach of children.
- Smoking should be avoided while paint is going on.
- The person supervising the painting process should protect his skin well from paint and related solvents. In case of any spillage on skin, warm soap water should be used for washing. If the paint still remains, then remove it with the solvent used for thinning the paint. After thin a good body lotion should be used to apply in the affected area.
- For painting doors and windows, the putty around the glass panes shall also be painted. Care shall be taken to see that no paint stains etc., are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting.
- Do not apply final coat of paint till final coat of snowcem / white washing done.
- To guarantee a neat edge around windowpanes, the glass should be protected with a paint shield or masking tape before painting. Remove it before final coat is dry to avoid peeling a layer of paint. Always allow paint to overlap slightly on the glass to prevent moisture from seeping into the joint between putty and glass. When spraying paint, the other surfaces around the area should be masked with sheets of paper or plastic to protect them.
- The drying time of enamels is longer; hence care must be taken to ensure a dust free environment while the paint film is drying.
- Observe painted surface for paint drips, dabs, brush marks, waves and for variation in colour, texture and finish.
- Check the places that are difficult to reach such as edges, corners, crevices, welds, bolts & nuts, top and bottom of shutters.
- No primer is recommended for exterior surface (in case of newly plastered surfaces).

6.3 Tools and Equipments

Sr. No.	Tools & Equipments	Purpose/Use
1.	Knives	
	a) Putty Knife	Used for applying putty to cover dents, undulation, cracks, knots in wooden surfaces.
	b) Scrapping Knife	Used for removing old paints and hard materials from surface and not to use on oily or greasy surface directly.
	c) Chisel Knife	Used for cutting hard old thick paint.
	d) Moulding Knife or Contour Knife	Used for scraping or rubbing on peculiarly shaped/contours like statue, ornamental carving, curved portions etc.
	e) Pallet Knife	Used for mixing the paint in drums.
	f) Stencil Knife	Used for cutting stencils.
2.	Brushes	
	a) Flat Brush	Used for painting generally flat wooden and metal surfaces.
	b) Round Brush	Used for painting very large areas quickly for preparatory application.
	c) Curve Brush	Used for painting curved surfaces of irregular design.
	d) Taper Brush	Used for white washing covering large area of contact.
	e) Wall Brush or ground brush	Used for painting walls.
	f) White wash Brush	Used for white washing.
	g) Calcimine Brush	Used for applying calcimine or water paint to ceiling and walls and not used for applying oil paints.
	h) Dust Brush	Used for removing dust, dirt before painting.
	i) Wire Brush	Used for removing tightly adhering rust on metal surfaces.
	j) Stencil Brush	Used for stencil work.
	k) Artist Brush	Used for lettering/arts
	l) Stippler Brush	Used for painting on very rough surfaces.
3.	Blow lamp	Used for removing thick old paint from metal surfaces by heating and not used on wood, glass, cement surfaces
4.	Pallet board	Used for mixing various colours by artists.
5.	Plumb ball	Used for drawing vertical lines.
6.	Emery sheets available in four types: Sand paper, Cloth emery, Water proof emery, Abrasive stones.	a) Used for removing unwanted materials b) Used for creating surface roughness
7.	Shade card	Used for choosing shades of a single colour.
8.	Stencil paper	Used for cutting or making stencil.
9.	Viscosity	Used for measuring the consistency or flow of paint.
10.	Elcometer	Used for measuring dry film thickness (DTF) of paint in microns and this works on electromagnetic principle. (1micron=0.001mm)
11.	Gloss meter	Used for measuring gloss value of dry paint film.
12.	Wet flatting machine	Used for flattening the putty applied areas.
13.	Drop sheet	Available in the form of paper, gunny bag, polythene paper etc. to protect flooring and furniture from paint particularly used for ceiling and interior works.
14.	Ladder	Essentially used for painting ceiling, side walls etc.
15.	Masking tape	Used for covering areas which are not to be painted.
16.	Paint bucket	Used for containing paints for painting.
17.	Straight edge/Ruler	Used for drawing straight line bands, border line etc.
18.	Strainer	Used for filtering the paint to remove dust, dirt and other insoluble materials before applying paint on the surface.
19.	Brush holder	Used for keeping brushes after completing the painting.
20.	Rubber block	Used for flatting small, curved areas where wet flatting machine can not be used.
21.	Spray Gun	Used for painting the surfaces by mode of spraying.

6.4 Good Quality Paint Brushes and Rollers

6.4.1 Paint Brush

Brush is an important tool for painting and available in various sizes and various shapes for different types of works. A wide range of brush sizes are available in market including 38mm, 50mm, 60mm and 75mm. Since the majority of homes use water based paints or oil based paint, a good quality synthetic brush may be the right choice for painting the surfaces. The quality of the brush used has a direct effect upon the quality of the finished job and the ease with which the paint is controlled and applied.

A good quality paint brush should have the following characteristics:

- It feels thick and full, holds more paint, and covers more surface area.
- It has tapered filaments releasing paint gradually, evenly, and smoothly.
- It has good length of bristles with 'tipped' and 'flagged' to give better paint pickup, greater coverage and easier application.
- It has high quality filaments for carrying the work faster and smoother irrespective of the surface to be painted.

6.4.2 Roller

A high quality *roller frame* and *roller* will give the best paint coverage and surface finish. A *roller cover* with the correct fabric should be choosed for the paint and surface being painted.

1. Choosing a Roller Frame

- Rollers and frames come in three basic sizes, 180mm and 230mm and 270mm. The 180 mm to 230mm sizes cover less surface area but are lighter and easier to work with.
- Choose a strong roller frame that is not easily bent and the cage assembly is tight and spins freely.
- Ensure that the handle has a comfortable grip and is aligned with the centre of the cage for improved stability and even pressure application.
- The roller frame should have a cap at each end to prevent paint from collecting inside the cover and to allow it to roll smoothly.
- The frame grip should be comfortable and have a hollow threaded end to fit an extension pole.

2. Choosing the correct Roller Covers

- A high quality roller cover should have a phenolic core that will not soften in water and will withstand every paint solvent.
- Roller covers are made in varying thicknesses, each one designed for a specific surface texture. A thickness or nap of 6mm is for very smooth surface, 12mm for slightly uneven surfaces and 20mm for rough surface.

3. Choosing the Roller

Rollers can be made from foam, synthetic fibres and lambs wool and offer different benefits.

Foam Rollers

- Because they are seamless, these rollers lay down a smooth, tint-free coat of paint.

- Since paint can be laid down faster without brush streaks with a foam roller, trim and edge foam rollers are ideal for reaching into corners and adjacent walls and ceilings.
- Since foam itself does not absorb paint, foam rollers clean up easily with water if latex paint used or with the correct solvent if paints used other than latex.

Synthetic or Synthetic/Lambs Wool blend Rollers

- Recommended for the trade.
- Due to the man made fibre they are very durable and able to cope with constant trade use.
- The denser fabric traps more paint when loading. Stronger roller action is required to release the paint.

Lambs Wool and Mohair

- Being a natural animal fibre, it has inherent properties of durability, and will stand the test of time.
- The natural oils make it easy to clean compared with regular synthetic fibres, thereby further enhancing the roller life span.
- Lambs wool is a soft and fine fibre, ensuring perfect paint pick up and release without overloading and paint splatter.
- The fine wool fibres of the mohair rollers guarantee a highly specialised mirror finish, and can be used for all gloss paints as well as varnishes, epoxies, enamels and polyurethane clear coatings.
- The roller 'nap' refers to the thickness of the roller surface. A 6mm nap is recommended for flat wall and ceilings. 12mm nap for surfaces with small imperfections and 20mm nap for textured surfaces.

6.5 Safety Measures

Safety occupies the first place in any industry and is important to every one in an organisation to learn safe work habits. Certain safety rules which pertain to Painting trade are classified into three major heads:

6.5.1 Safe Storage of Paints

- Paints being inflammable material should be protected against fire hazards by

  a) providing fire extinguishers and sand buckets at easily accessible places.
  b) applying fire retardant paint on walls of store room.
  c) keeping away fire prone materials such as wood, cotton waste etc.
  d) displaying 'No Smoking' Boards at all important locations.

- Electrical short circuiting should be avoided in paint stores by way of providing concealed (electrical) wiring.
- Proper ventilation arrangements should be provided where paints are stored.
- Water should not be used to extinguish the fire.

6.5.2 Safe Working of Painter

- A safety kit consisting of the following items should be provided to the painter.

  a) *Protective clothing* while working with painting machinery and running parts.
  b) *Rubber gloves* while dealing with chemicals and acids.

c) *Leather gloves* while handling sheet metals to protect against the sharp edges of sheet metal.
d) *Boots* to prevent slipping on oily floors or floors with paints.
e) *Helmet* while working overhead and beneath the underframe and in mines to protect the head.
f) *Goggles* while grit blasting to protect eyes.
g) *Spray mask* while spray painting.

- It is safe not to take any beverages inside the paint store or shop, since lot of volatile matter is stored there.
- Spray gun should be operated by trained persons only.
- Paints should not be mixed with bare hands.

6.5.3 Safe Working Environment

- A safe working environment should be maintained in a building or structure during painting by providing

a) Proper exhaust fan arrangement for discharging the fumes and other dust particles.
b) Adequate lighting and ventilation arrangements.
c) All electrical disconnections before painting machinery or electrical equipments.
d) Proper ladder facility and suitable place for keeping paint buckets while painting roofs.
e) Proper insulation while working with wet flatting machines since water is used during this operation.

- Oily floors should be cleaned to avoid slipping of workmen or ladder.
- Gangways and pathways should be kept clear and free to have easy access in case of emergencies.
- Used cotton waste should be properly disposed.

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Annexure - 1

The following Indian Standards are listed here for reference prior to the painting of masonry surfaces, metal surfaces and wood surfaces.

75-1973	Linseed Oil, raw and refined (second revision) (with amendment No. 1) (Reaffirmed 2006).
77-1976	Linseed oil, boiled, for paints (second revision). (Reaffirmed2006)
102-1962	Ready mixed paint, brushing red lead, setting priming (revised) (with amendment No. 1) (Reaffirmed 1996).
104-1979	Ready mixed paint, brushing, zinc chrome, priming (second revision). (with amendment No. 1) (Reaffirmed 2004).
109-1968	Ready mixed paint, brushing, priming, plaster, to Indian Standard Colour No. 361 light stone and No. 631 Light grey first revision) (with amendment No. 1) (Reaffirmed 1976).
110-1983	Ready mixed paint, brushing grey filler, for enamels for use over primers (second revision)
133-2004	Enamel, interior (a) under coating, (b) finishing (third revision).
137-1965	Ready mixed paint, brushing matt or egg-shell, flat, finishing interior to Indian standard colour as required (revised) (with amendment No. 1) (Reaffirmed 1999).
158-1981	Ready mixed paint, brushing, bituminous, black lead free, acid, alkali and heat resisting (third revision) (Amendment No. 1) (Reaffirmed1999).
218-1983	Creosote oil for use as wood preservative (second revision) (Reaffirmed1998)
290-1961	Coal tar black paint (revised) (Reaffirmed 1996)
324-1959	Ordinary denature sprite (revised) (with amendment No. 1) (Reaffirmed 2002)
337-1975	Varnish, finishing, interior (first revision). (Reaffirmed 2001)
340-1978	Varnish, mixing (first revision).
345-1952	Wood filler, transparent, liquid (with amendment Nos. 1 and 2 (Reaffirmed 1986).
347-1975	Varnish shellac for general purposes (first revision) (Reaffirmed 2001)
348-1968	French polish (first revision) (with amendment Nos.1) (Reaffirmed 2001).
384-2002	Brushes, paints & varnishes, flat (fourth revision)
423-1961	Plastic wood for joiners fillers (revised) (with amendment No. 1) (Reaffirmed 2001)

430-1972	Paint remover, solvent type, non-flammable (second revision) (Reaffirmed 1999).
486-1983	Brushes, sash tool, for paints & varnishes (third revision) (Reaffirmed 1998)
487-1997	Brush, paint and varnish (i) oval, ferrule bound and (ii) round, ferrule bound (fourth revision)
524-1983	Varnish, finishing, exterior, synthetic, air drying (second revision). (Reaffirmed2005)
525-1968	Varnish, finishing, exterior and general purposes (first revision) (with. amendment No.1) (reaffirmed 2001).
533-1998	Gum spirit of turpentine (oil of turpentine) (second revision) (with amendment Nos. 1 and 2) (reaffirmed 1978).
1103-1984	Brushes artist's (third revision) (with amendment No. 1). (Reaffirmed2003)
1104-1984	Brushes, lettering (lettering) (Reaffirmed 2003)
1303-1983	Glossary of terms relating to paints (second revision). (Reaffirmed2001)
*1477(Pt.-I) - 1971	Code of practice for painting of ferrous metals in buildings: Pre-treatment (First Revision) (Reaffirmed 1979)
*1477 (Pt.-II) 1971	Code of practice for painting of ferrous metals in Buildings: Painting (First revision) (Reaffirmed 1979)
2074-1992	Ready mixed paint, air drying, red oxide-zinc chrome priming (first revision) (with amendment No. 1 to 4) (Reaffirmed 2002)
2338 (Pt.-I) - 1967	Code of practice for finishing of wood and wood based materials: Operations and workmanship (Reaffirmed2000)
2338 (Pt.-II) - 1967	Code of practice for finishing of wood and wood based materials Schedules (Reaffirmed2000)
2339-1963	Aluminium paint for general purposes in dual container (with amendment No.1 & 2) (Reaffirmed 2004).
*2395(Pt.-I) - 1994	Code of practice for painting concrete, masonry and plaster surfaces:. Operations and workmanship (Reaffirmed2005)
*2395 (Pt. II) - 1994	Code of practice for painting concrete, masonry and plaster surfaces: Schedules (Reaffirmed2005)
*2524 (Pt.I) - 1968	Code of practice for painting of non-ferrous metals in buildings: Pre-treatment (Reaffirmed2000)
*2524 (Pt.II) - 1968	Code of practice for painting of non-ferrous metals in buildings: Painting (Reaffirmed2000)

2932-2003	Enamel, synthetic, exterior (a) under coating (b) finishing (third revision) (with amendment No. 1& 2)
2933-1975	Enamel, exterior (a) under coating, (b) finishing (second revision)(with amendment No. 1 & 2) (Reaffirmed 2001).
3140-1965	Code of practice for painting asbestos cement building products (Reaffirmed2000)
3536-1999	Ready mixed paint, brushing, wood primer, pink (with amendment No. 1 to 4)
3585-1966	Ready mixed paint, aluminium, brushing, priming water resistant for wood work (with amendment No. 1) (reaffirmed 1999).
5411 (Pt.I) – 1974	Plastic emulsion paint for interior use (first revision) (with amendment No. 1)(Reaffirmed 1993).
5660-1998	Ready mixed paint, brushing aluminium red oxide primer (Reaffirmed1998)
6005-1998	Code of practice for phosphating of iron and steel (reaffirmed 1979).

Note: *The Standards marked with (*) are referred for preparing the handbook on* ***'Comprehensive Guide on Painting for Buildings'***.

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OUR OBJECTIVE

To upgrade Maintenance Technologies and Methodologies & achieve improvement in productivity and performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability, and Utilisation.

*The contents of this handbook are for guidance only & are **not statutory**. It also does not supersede any existing specification and instructions from Railway Board, RDSO, and Zonal Railways & the provisions of IRWM, BIS Codes/Reports on the subject. If you have any suggestion & any specific comments, please write to us:*

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