BRITISH STANDARD

BS 4479-4: 1990

Design of articles that are to be coated —

Part 4: Recommendations for paint coatings and varnish coatings

UDC 672/673:621.795:006

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Pigments, Paints and Varnishes Standards Policy Committee (PVC/-) to Technical Committee PVC/27, upon which the following bodies were represented:

Aluminium Coatings Association
Aluminium Federation
Aluminium Window Association
British Railways Board
British Tar Industry Association
British Telecommunications plc
Consumer Policy Committee of BSI
Department of the Environment (Building Research Establishment)
Department of Trade and Industry (Laboratory of the Government Chemist)
Electricity Supply Industry in England and Wales
Institute of Metal Finishing
Institute of Petroleum
Institution of Corrosion Science and Technology
Institution of Structural Engineers
Institution of Water and Environmental Management (IWEM)
London Regional Transport
METCON
Ministry of Defence
Oil and Colour Chemists' Association
Paint Research Association
Paintmakers' Association
Society of Chemical Industry
Steel Window Association
Union of Construction Allied Trades and Technicians
Zinc Development Association

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Chartered Society of Designers
Hevac Association
Home Improvement Powder Coatings Association

This British Standard, having been prepared under the direction of the Pigments, Paints and Varnishes Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 July 1990

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Contents

Foreword

This Part of BS 4479 has been prepared under the direction of the Pigments, Paints and Varnishes Standards Policy Committee and is based on a draft prepared by the Institute of Metal Finishing. The BSI Technical Committee acknowledges the contribution to this revision by the Institute[1)] and by the Committee for the Promotion of Electroplating. This Part of BS 4479 is one of a series of Parts which together form a revision of BS 4479:1969. On publication of all the Parts, BS 4479:1969 will be withdrawn. This revision of BS 4479 comprises the following Parts:

— *Part 1: General recommendations;*

— *Part 2: Recommendations for electroplated and autocatalytic coatings;*

— *Part 3: Recommendations for conversion coatings;*

— *Part 4: Recommendations for paint coatings and varnish coatings;*

— *Part 5: Recommendations for anodic oxidation coatings;*

— *Part 6: Recommendations for hot-dip metal coatings;*

— *Part 7: Recommendations for thermally sprayed coatings;*

— *Part 8: Recommendations for vitreous enamel coatings;*

— *Part 9: Recommendations for low pressure and vacuum deposited coatings.*

BS 4479 is directed towards helping to maximize the benefit obtained from coating processes. There is a wide variety of coating processes, developed and established industrially, intended to enhance or transform the surfaces of manufactured articles. However, time and money are often wasted because the design of many articles is unsuitable for the coating process to be applied. Coating is only one part of the manufacturing process and should not be ignored, or viewed in isolation, when considering the overall costs and quality.

This revision of BS 4479 has been undertaken to extend the range of coating processes covered. It is not intended to cover every conceivable design detail and every type of article or service condition. Adherence to the general principles described will, however, greatly assist in the achievement of the desired results. In any case of doubt or difficulty, specialist advice in the particular type of process being considered should be sought.

This part of BS 4479 is not a specification and should not be used as such. The recommendations are intended to provide guidance towards good practice.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

[1)] Institute of Metal Finishing.

1 Scope

This Part of BS 4479 gives recommendations for the design of parts that are to be coated by painting or varnishing and covers four of the most commonly used methods whereby such coatings are applied, i.e.:

a) spray coatings;

b) dip coatings;

c) powder coatings;

d) electrophoretic coatings.

This Part of BS 4479 outlines the salient features of each method of application, and highlights the advantages and short-comings of each.

Design considerations are clearly given for each of the four processes, and Annex A illustrates some preferred and deprecated design features.

NOTE 1 Reference is made throughout this Part of BS 4479 to paint coatings. For the purposes of this standard, the term paint may be taken to include varnish in cases where the latter may be also applied by the process described.

NOTE 2 In many instances a paint system is preceded by some other surface treatment, e.g. phosphated steel or chromated aluminium, and the designer is directed to BS 4479-3 which deals with conversion coating.

NOTE 3 It is recommended that Part 1 of BS 4479 be read in conjunction with this Part. Part 1 includes a list of British Standards relating to processes covered by BS 4479 but not necessarily referred to in each part.

NOTE 4 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purpose of this Part of BS 4479, the definitions given in BS 2015 apply.

3 General

Organic and inorganic paint finishes are applied to various articles in order to provide a decorative effect or to protect the basic metal. In the construction, automotive and aircraft industries, for example, some articles cannot be easily or economically coated by other processes and hence painting by one means or another is the logical means of finishing.

Whatever paint application process is used, it is essential that surfaces should be adequately prepared prior to paint application with due regard to the coating system and expected conditions of service. Attention is drawn to the provisions of BS 7079.

4 Spray coatings

4.1 Process

There are two main processes used in the spray coating of paints:

a) manual application (see **4.2**);

b) electrostatic application (see **4.3**).

4.2 Manual spray coatings

4.2.1 *General*

On new work spray painting is the most widely used method of applying paint finishes because of its speed of application and its adaptability to almost any condition, shape or size of article.

In addition to the conventional types of spray gun, there are adaptations of these guns for particular applications and finishes, allowing the design engineer greater freedom in his choice of designs. Extension spray heads, for example, are available for spraying the interior of small necked vessels, tubes, pipes, cylindrical objects, etc. These heads may give a disc spray, cone spray or fan spray, and may be directed at a 45° or 90° angle to the direction in which the gun is pointed. Inaccessible spots may be sprayed by using a head with which the spray is directed backwards at an angle of 25° or more. Airless spraying gives further application advantages in that it allows penetration into small crevices and sharp corners with less danger of dry spray.

4.2.2 *Design considerations*

Despite the ability to spray awkward shapes by the various means described in **4.2.1**, it is still essential that the design engineer avoids certain shapes if at all possible. Access for maintenance should be considered at the design stage. The following principles should be observed.

a) The design should ensure that all surfaces are fully accessible for surface preparation and should permit complete and uniform application of the sprayed coating.

b) Structures should be so designed that any focal points of corrosion are avoided from which further corrosion can spread. Major corrosive factors are moisture and dirt in which marine and industrial corrosive agents can collect and concentrate. The elimination of all features that might facilitate lodgement or retention of moisture and dirt is, therefore, an important factor in the design.

c) Sharp edges should be avoided (see Figure 1 to Figure 3) by giving corners a minimum radius of 1 mm and smoothing out edges as much as possible. Fins and ribs should be spaced as widely as possible and edges made round and smooth (see Figure 4 and Figure 5). Corners and edges of indentations should be rounded to a radius of at least a quarter of their depth (see Figure 6). If blind holes are essential, they should be shallow with well rounded corners and edges (see Figure 7).

d) The designer should aim to reduce the number of protruding fasteners, e.g. bolts and rivets, to a reasonable minimum. Welded joints are preferred as they aid shaping of optimal surfaces. Monolithic components are best, if practicable (see Figure 8).

e) Continuously welded joints facilitate the preparation of good surfaces for painting. Intermittent or spot welding should be avoided [see Figure 9(a) and Figure 9(b)].

f) Butt-welded joints provide a better shape of surface than lap joints [see Figure 9(c) and Figure 9(d)].

g) Countersunk rivets or screws give a better surface profile than other types of corresponding fasteners (see Figure 10).

h) Thorough finishing or smooth grinding of welds is extremely important in obtaining a good clean surface for painting. The removal of welding residue, flux, weld metal spatter, burrs, and other similar surface defects prior to any type of overall surface cleaning should whenever possible be specified by the designer.

NOTE Most high performance coatings are applied to blasted steel. Where the treatment of welds as described in item h) is undertaken, reblasting of these areas is necessary before repriming.

i) Pin holes in soldered (or welded) joints should be avoided in order to produce sound coatings.

j) Methods of jointing likely to cause surface blemishes should be avoided, as these will either have to be removed or filled in at extra cost.

k) Machining marks on surfaces should be minimized as far as possible.

4.3 Electrostatically applied spray coatings

4.3.1 *General*

The application of coating materials to suitable articles by the electrostatic process has become increasingly important in industry, due mainly to the large paint savings made possible by the reduction of overspray and the ability of the electrostatic coating to "wrap" itself around the articles being sprayed. This is achieved by the paint material being electrically charged by various means and the article to be painted being earthed. The charged paint particles are attracted to the earth and "wrap" themselves evenly around the earthed article. This characteristic of the process enables the backs and fronts of objects to be sprayed at the same time.

4.3.2 *Design considerations*

The following principles should be observed.

a) Generally the same principles apply as for the manual spray application. Electrostatic application has one major disadvantage, however, and that is its inability to coat adequately the inside surfaces of an article. This is because no electrostatic charge exists on the inside surfaces and hence no paint is attracted to it. Therefore, if the article has to be painted electrostatically, the designer should avoid recesses and cavities. In some cases this will obviously not be possible, in which case an alternative paint application method should be used.

b) If articles have to be sprayed electrostatically, the designer should avoid holes and slots on highly visible finished surfaces. The electrostatic attraction produces a build-up of paint on the edges of such shapes, causing runs and sags.

5 Dip coatings

5.1 Process

The simplest method of dip coating consists of lowering the article to be coated into a container of paint until it is submerged to the desired level, lifting it out and hanging it over the container, or over drain areas, whilst the surplus paint drains off. There are, however, several inherent disadvantages with this particular method, which can be briefly summarized as follows.

a) Due to the article shape, paint may be held in pockets or depressions, giving rise to pools which do not drain properly.

b) The article shape may give rise to runs and sags.

c) "Fatty edges" (surplus paint along the edges) may form, together with tears at the corners.

d) Holes may be blocked and gaps and threads bridged.

e) In enclosed sections, refluxing (or solvent washing) may occur.

f) The film thickness is always thicker at the bottom than at the top, due to drainage.

For small items, a variation of dip painting which can be used is "tumbling" or barrel painting. In this, the articles to be painted are tumbled in a barrel, octagonal or cylindrical in shape, and containing a small amount of paint until they are coated all over. They are then either tipped onto wire trays and stoved or, alternatively, the paint is drained out of the barrel and the articles are tumbled until they are dry.

5.2 Design considerations

The main design criteria for parts to be dipped is that allowance should be made for maximum drainage. This can also be influenced by correct jigging of parts to be painted (see Figure 11) and by the correct positioning of holding points in order to avoid runs onto significant surfaces (see Figure 12). Other points to consider are as follows.

a) Hollow articles should have drainage holes located in the lowest possible position with angles assisting drainage (see Figure 13).

b) Rolled and bent edges should be avoided as these can trap paint (see Figure 14).

c) Close bends of 180° should be avoided by using wide U-bends (see Figure 15).

d) Horizontal flat surfaces are potential focal points for corrosion attack arising from retention of moisture and dirt. Therefore, wherever possible, design provision should be made for evaporation, run-off or drainage of moisture. Such drainage also gives a better paint appearance (see Figure 16).

e) If large articles are being designed with the intention of being dip painted, holes should be provided in sufficient number and size to ensure that the articles sink within a reasonable time.

f) If small flat articles are being designed for barrel or basket painting, they should incorporate a dimple or raised edge to prevent them sticking together.

g) Machining marks on surfaces should be minimized as far as possible.

6 Powder coatings

Powder coatings can provide an improved resistance to corrosion compared with most wet paint systems but, like other systems, they should still be regarded as semi-permeable membranes. These coatings are usually harder than those produced by wet paint systems. They are applied either electrostatically or by fluidized bed methods, and the design considerations given in **4.3.2** and **5.2**, respectively, generally apply.

It is most important that the basis metal is given the correct pretreatment. Without good pretreatment the adhesion, durability and weathering characteristics will be adversely affected.

Powder coating always involves pretreatment either by the dip or spray method. For this reason, the design considerations regarding solution entrapment are the same as those recommended for conversion coatings (see BS 4479-3). The provision of adequate drainage holes is most important and large drainage holes may be required where powder coatings are applied by the fluidized bed method. Avoidance of sharp edges and deep recesses apply equally to powder coatings as to wet coatings. However, the danger of paint runs or puddles is minimized by the use of powder coatings.

Attention should be paid to the problem of welded, soldered or brazed joints, as some materials in common use are not compatible with some pretreatment systems or curing schedules. It is important for the designer to discuss this matter with the applicator at the design stage. Similarly, components comprising two different metals should be avoided where possible and, where the problem is unavoidable, it should be discussed with the applicator.

One of the most frequent problems encountered is the poor surface condition of the metal to be coated. If a good visual appearance is required, the substrate should be smooth and free from blemishes and imperfections. For exterior use steel is often galvanized and pretreated prior to powder coating and aluminium should be chromated to enhance its corrosion resistance. For steel sheets, galvanizing should be in accordance with BS 2989 and for other items it should be in accordance with BS 729.

Galvanized coatings should be smooth, continuous and free from flux stains. It is recommended that samples of the product are coated in order to establish an acceptable finish.

The following additional points should be observed.

a) Welds should always be ground to give a finish consistent with that of the steel surface and weld spatter should be removed. Pit marks in the weld surface will show through a powder coating and can constitute potential corrosion sites.

Where the steel is to be galvanized, any welding or cleaning operations should be done before galvanizing so that all areas receive the same treatment as variations in finish may otherwise arise. Machining marks on surfaces should be minimized as far as possible.

b) Where brazing or soldering is required during fabrication, it is essential that the solder should be able to withstand temperatures up to 220 °C.

c) All hollow sections should be provided with adequate holes so that pretreatment chemicals can drain out. This applies even to totally enclosed sections because solutions will even pass through welded seams. It is advisable to discuss the design of hollow fabrications with the applicator at the design stage.

d) The surface condition of the basis metal will reflect the appearance of the applied finish. The ease with which a high quality finish can be obtained is dependent upon the choice of material, e.g. steel or aluminium, and the surface finish produced prior to painting.

e) Roll joints should be coated prior to making the joint.

f) Coated sheet or tube may be bent or formed, but should not be cut, drilled or welded.

g) Masking for selective painting is possible, but not desirable, and should therefore be avoided, where possible, in the design.

h) The ratio of thick to thin sections on any one part should not exceed 4 : 1.

7 Electrophoretic coatings

7.1 Process

Electrophoretic coating is a process by which paint is deposited onto an electrically conductive surface by passing a d.c. current through a tank of water-based paint. Two systems exist, known as anodic or cathodic electrodeposition, depending on whether the article to be painted is the anode or the cathode in the electrical circuit. The deposited film is a poor conductor of electricity so that, once a deposit has been formed, the current is concentrated on uncoated areas to give a substantially uniform thickness of paint over the whole surface, subject to there being adequate access for the liquid paint and electrical current to reach all surfaces to be painted, and adequate immersion time.

7.2 Design considerations

The electrophoretic coating process allows the design engineer more freedom for his design and is not limited to normal painting constraints. It will, for instance, give good paint coverage on sharp corners and edges with a minimum radius of 0.5 mm and can eliminate runs and sags. Its major use, however, is in providing paint coverage, and hence corrosion protection, for areas which cannot be painted reliably by other means, for example the insides of box sections. To achieve this, however, the box itself needs to have adequate electrical access. This is often provided by holes needed for mechanical reasons or by drainage holes, but sometimes extra holes have to be provided to carry enough electrical current into the box. Suppliers of electrophoretic coating systems have computer programs to assist design engineers which, given certain criteria on box sizes, voltages and deposition time, can predict the number and size of holes required. The following general points, however, should be taken into account.

a) The exact hole positioning is not very important. Holes should, however, be reasonably evenly spaced and provide a reasonably unobstructed current path.

b) Adequate provision should be made for drainage and for venting air pockets (see Figure 17).

c) The shape of hole is not important but welded nuts and swages and very narrow slots are relatively ineffective.

d) The design should incorporate an electrical connection point, preferably away from the main visible area or surface.

e) The design should also incorporate jigging points arranged such that the article to be painted drains well and, during immersion, avoids air trapping. Horizontal positions should be avoided and, in order to allow the gas generated to escape, an angle of about 12° should be used.

f) Box sections should have drainage and access holes as shown in the example section illustrated in Figure 18. Drainage holes should be provided in face B. Access holes should be provided in face A and, to ensure full painting of total inside sections, holes should be added to the baffle plate (if present). The total area of these holes should be at least as great and preferably greater than that of the holes in face A.

Annex A Diagrams illustrating preferred and deprecated design features for articles to be painted or varnished

Diagrams illustrating preferred and deprecated design features for articles to be painted or varnished are given in Figure 1 to Figure 18.

(a) Deprecated design (b) Preferred design

NOTE Corners should have a radius of least 1 mm.

Figure 1 — Corners

(a) Deprecated design (b) Preferred design

NOTE Edges should be smoothed out as much as possible.

Figure 2 — Edges

(a) Deprecated design (b) Preferred design

NOTE Sharp edges and corners of slots should be eliminated.

Figure 3 — Slots

(a) Deprecated design (b) Preferred design

NOTE Fins should be spaced as widely as possible and the edges rounded.

Figure 4 — Fins

(a) Deprecated design

(b) Preferred design

NOTE Ribs should be smoothed in section and spaced as widely as possible.

Figure 5 — Ribs

(a) Deprecated design

(b) Preferred design

NOTE Corners and edges of indentations should be rounded to a radius of at least a quarter of this depth.

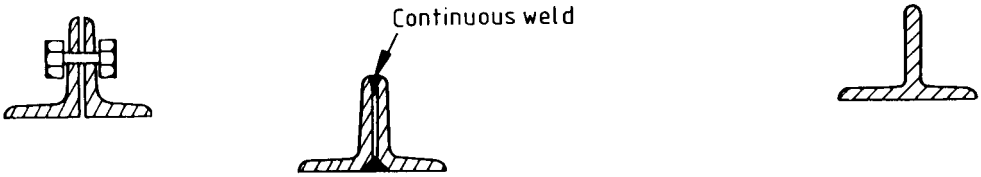
Figure 6 — Indentations

(a) Deprecated design

(b) Preferred design

NOTE If blind holes are essential they should be shallow with well rounded corners and edges.

Figure 7 — Blind holes

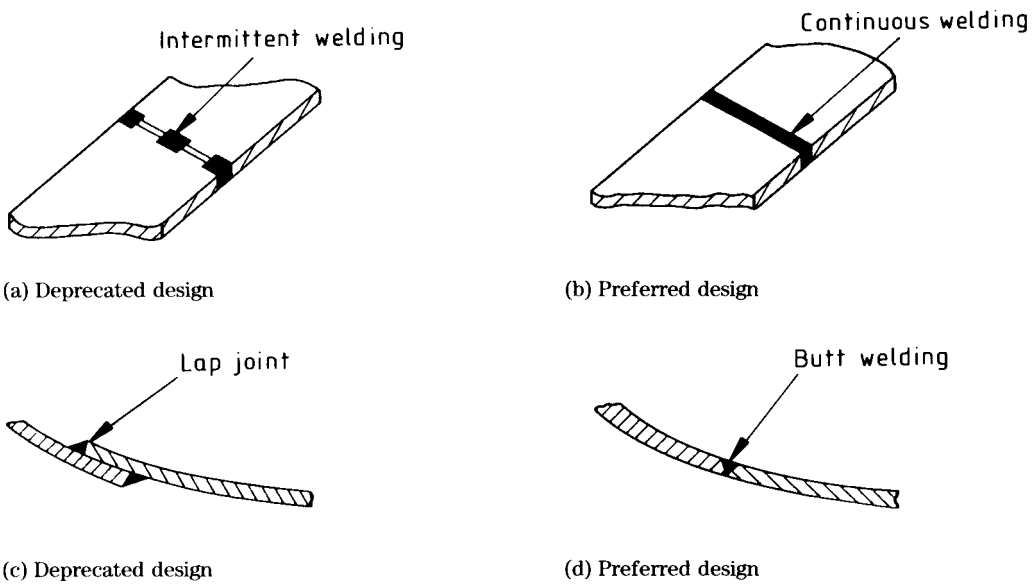


(a) Deprecated design

(b) Acceptable design

(c) Preferred design

Figure 8 — Joints



(a) Deprecated design

(b) Preferred design

(c) Deprecated design

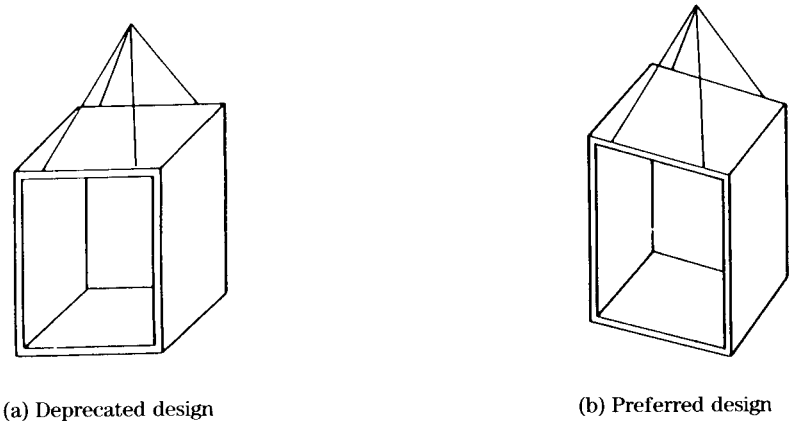
(d) Preferred design

Figure 9 — Welds

(a) Deprecated design

(b) Preferred design

Figure 10 — Rivets

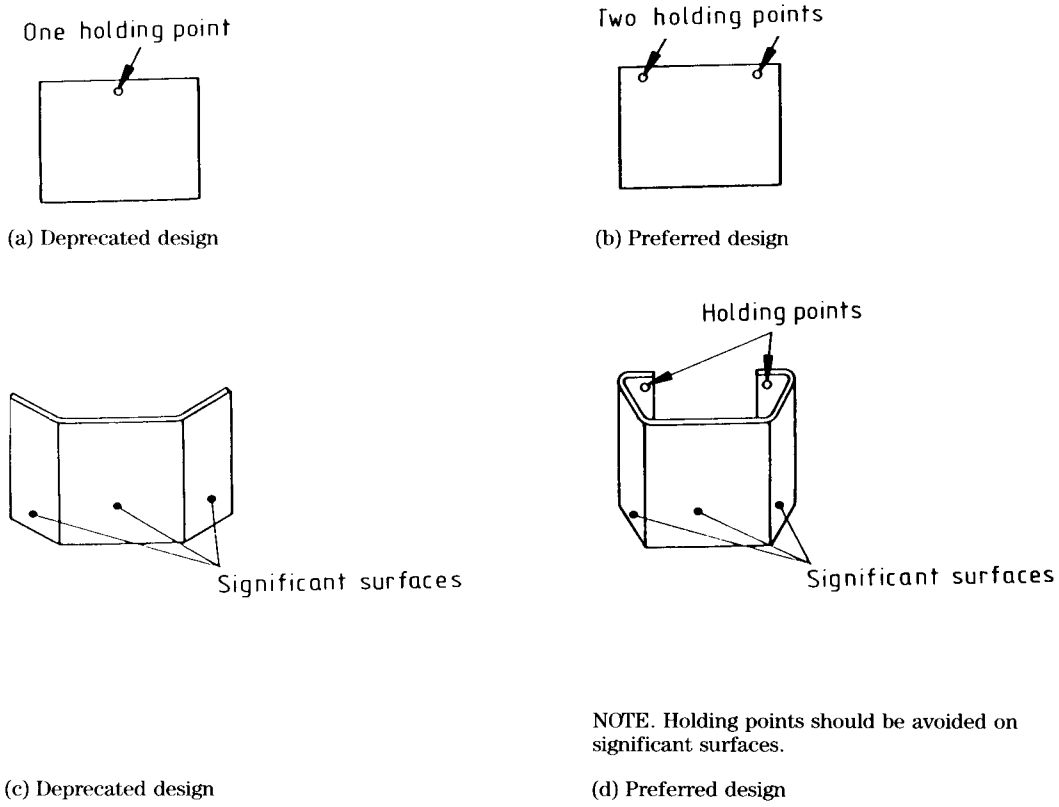


(a) Deprecated design

(b) Preferred design

NOTE Provision should be made for suspending articles so that during drying there are no horizontal flat surfaces and drainage takes place on the outside from one bottom corner. Alternatively internal drainage holes should be provided.

Figure 11 — Drainage



(a) Deprecated design

(b) Preferred design

(c) Deprecated design

NOTE. Holding points should be avoided on significant surfaces.

(d) Preferred design

Figure 12 — Holding points

(a) Deprecated design

NOTE. Drainage holes should be provided in hollow articles.

(b) Preferred design

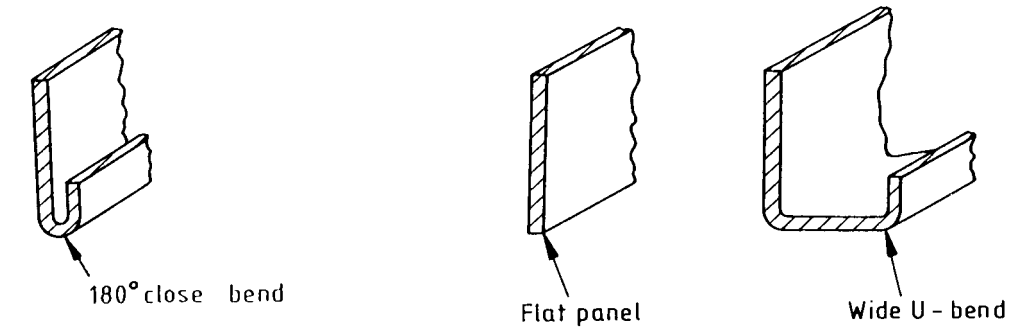
Figure 13 — Hollow articles

(a) Deprecated design

(b) Preferred design

NOTE The edges should be so designed that paint cannot be trapped.

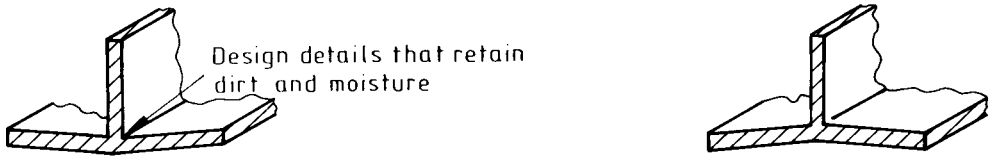
Figure 14 — Rolled and bend edges



(a) Deprecated design (b) Preferred design

NOTE The bends should be so designed that paint cannot be trapped.

Figure 15 — Bends



NOTE. The web plate should be pre-set to assist moisture run-off.

(a) Deprecated design

(b) Preferred design

Figure 16 — Flat surfaces

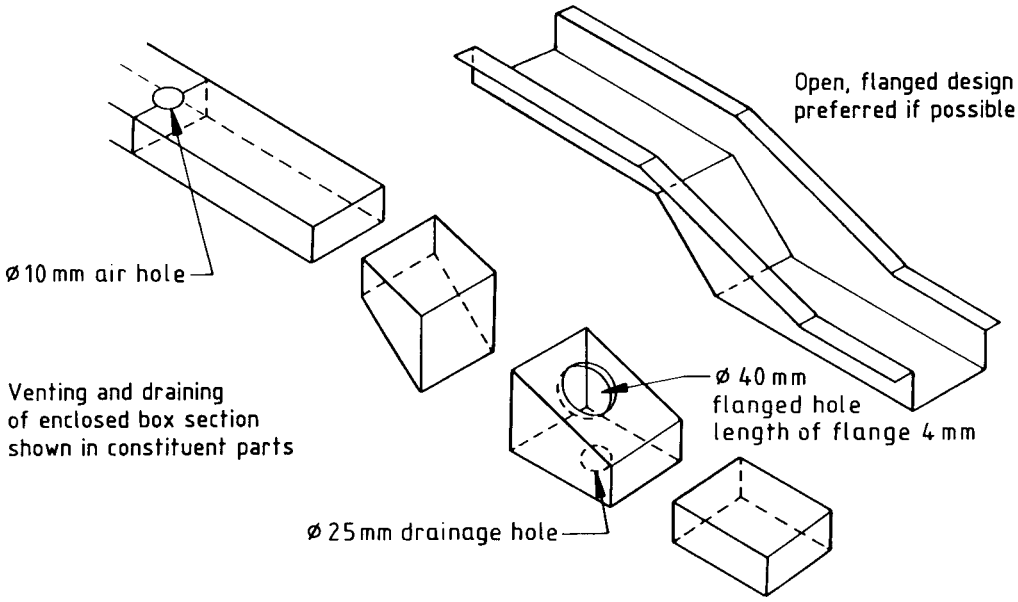
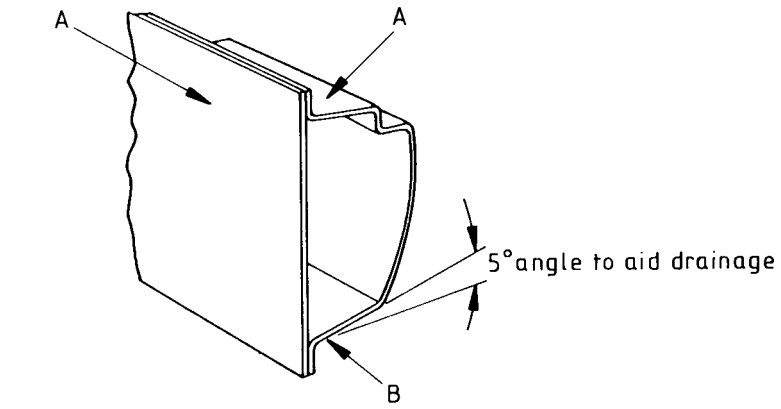


Figure 17 — Ideal box section: draining and venting



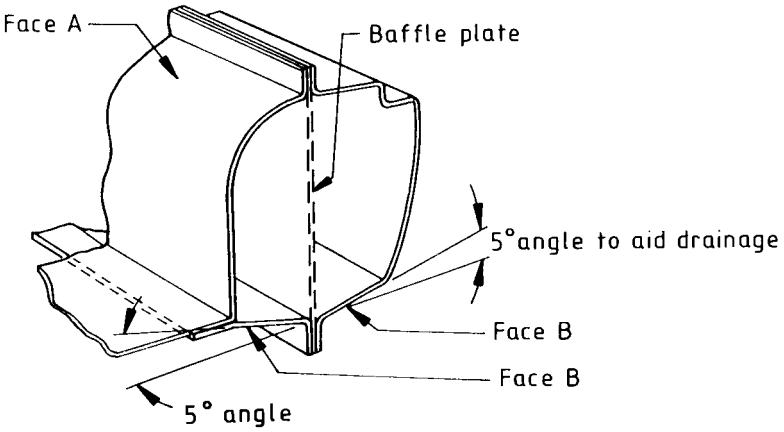


Figure 18 — Single box section: draining and access

Publications referred to

BS 729, *Specification for hot dip galvanized coatings on iron and steel articles.*

BS 2015, *Glossary of paint terms.*

BS 2989, *Specification for continuously hot-dip zinc coated and iron-zinc alloy coated steel: wide strip, sheet/plate and slit wide strip.*

BS 4479, *Design of articles that are to be coated.*

BS 4479-1, *General recommendations.*

BS 4479-3, *Recommendations for conversion coatings.*

BS 7079, *Preparation of steel substrates before application of paints and related products.*

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