BRITISH STANDARD

BS 4479 :
Part 6 : 1990

UDC 672/673 : 621.795 : 006

Design of articles that are to be coated

Part 6. Recommendations for hot-dip metal coatings

Conception des articles à revêtir
Partie 6. Recommandations pour les revêtements métalliques déposés par immersion à chaud

Gestaltung zu beschichtender Gegenstände
Teil 6. Empfehlungen für Feuerbeschichtungen

STANDARDS

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Surface Coatings (other than Paints) Standards Policy Committee (SRC/-) to Technical Committee SRC/10, upon which the following bodies were represented:

British Anodising Association
Institute of Metal Finishing
Institute of Sheet Metal Engineering
Institute of Vitreous Enamellers
International Tin Research Institute
Metal Finishing Association
Welding Institute
Zinc Development Association

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The following BSI references relate to the work on this standard:
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Contents

Foreword

This Part of BS 4479 has been prepared under the direction of the Surface Coatings (other than Paints) 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 On publication of all the Parts, BS 4479 : 1969 will be withdrawn.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, 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.

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

[1)] Institute of Metal Finishing.

Recommendations

1 Scope

This Part of BS 4479 gives recommendations for the design of metal parts that are to be coated by hot dipping; it deals mainly with the application of zinc (galvanizing), tin, tin-lead (solder) and lead-tin.

These recommendations apply to articles that are hot-dip galvanized or tinned after fabrication, or semi-fabrication. They do not apply to continuously hot-dip galvanized or tinned sheet, strip or wire.

NOTE 1. 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 2. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 4479, the following definitions apply.

2.1 hot-dip metal coating

A coating obtained by dipping the workpiece into a bath of molten metal.

2.2 hot-dip galvanized coating

A coating of zinc, and zinc-iron alloy layers, obtained by dipping prepared iron or steel articles in molten zinc.

NOTE. Under some circumstances the whole coating may consist of zinc-iron alloy layers.

3 General

It is essential that the design of any article required to be coated should take into account the function and desired life of the article, the method of manufacture and also any implications arising from the coating process.

Hot-dip galvanized coatings are used extensively to provide long life protection for steel articles, such as structural steelwork, and building construction accessories. An intermetallic layer is present in hot-dip coatings which is less ductile than the remainder of the coating. In the case of galvanized coatings, the intermetallic layer consists of several iron-zinc compounds which normally constitute a significant proportion of the coating.

With galvanized articles, areas of steel exposed by cutting, welding, etc., may be protected by the sacrificial action of the zinc on adjacent surfaces. Tin, or tin-lead coatings only provide a corrosion resistant overlay and basis metal, such as steel, exposed at pores in the coating is not protected by these coatings. These coatings are frequently used to provide an easily solderable surface on different basis metals and have the virtue that the basis metal has already been wetted by the tin, or tin-lead, during the dipping process and so been given a metallurgical bonding.

Mechanical assemblies may be made rigid by a hot-dip process. Since all crevices should be filled with the coating metal, this will also provide a seal where required.

It is essential that the effect of heating of the basis metal during the hot-dipping process be borne in mind at the design stage, especially with hot-dip galvanizing where temperatures of about 450 °C are generally used. This can lead to the relief of stresses and linear expansion giving rise to distortion in some instances and possible fracture of welds. These effects can be minimized by the use of symmetrical section and by the design of the fabrication so that it can be immersed rapidly in a single dip. Corrosion fatigue resistance can be improved and other basis metal properties are little changed by hot-dip galvanizing. Changes in the properties of the substrate will not occur during hot dipping in tin or tin-lead as the process temperature is lower, i.e. between 300 °C and 330 °C. The coating thickness obtained by hot-dip galvanizing is determined by a number of factors, including the surface roughness and chemical composition of the steel. The silicon content of the surface, rather than the bulk of the steel article, is particularly important.

Zinc coatings are applied by hot dipping on steel and cast iron but there is a significant use of tin and tin-lead alloy coatings on copper base materials, as well as on ferrous articles.

Galvanized steel can be readily welded by all the processes used for bare steel but welds on tin coated steel may be embrittled. It is essential that proper precautions are taken in view of the zinc oxide fume produced during the welding of galvanized steel. It is generally also necessary to post-treat welded areas.

4 Surface preparation

Good surface preparation is essential for the production of a high quality coating. It is essential that surface contaminants, including those which cannot be removed by pickling, e.g. oil, fat, paint, welding slags and spatter and similar impurities such as anti-spatter compounds, be completely removed. Surfaces should be free from defects to ensure a coating of good appearance and serviceability. Tin and tin-lead alloy may dewet, especially if the steel is not given an adequate preparatory treatment. It is essential that lacquers, wax, paint, oil and grease-base markings be avoided.

NOTE. Further information on the cleaning and preparation of metal surfaces is given in CP 3012.

Graphite exposed at the surface of iron castings will interfere with wetting by molten metal, and those castings which have been annealed may have silica particles in the surface layers which have to be removed in order to obtain a good quality hot-dipped coating. Grit blasting is recommended both before and after annealing.

5 Procedures

The hot-dip bath and associated plant should be of adequate capacity to process the articles to be hot-dip coated. Fabrications which are too large for the available baths may be partially immersed and then reversed for length or depth so that a complete coating is obtained. Tin and tin alloy coatings are not usually applied by this technique.

Brazed assemblies can be coated with tin or tin-lead alloys. If brazed assemblies are required to be galvanized care should be exercised, and the galvanizer consulted in advance. Assemblies comprising different metals requiring different pretreatments should be discussed with the processor. Soft soldered assemblies cannot be hot-dipped.

Since corrosive fluxes may be used in these processes, removal of flux residues after the coating process is essential to avoid corrosion of the coated parts and parts should be designed to facilitate this.

6 Design features

Diagrams illustrating preferred and deprecated design features for articles to be hot-dip coated are given in appendix A.

Warning. It is essential that sealed compartments be avoided or be vented, otherwise there may be a serious risk of explosion.

The provision of holes for venting and draining tubular fabrications will also allow a coating to be obtained on the inside surfaces and therefore ensure better protection for the fabrication. Large variation in thickness or cross section should be avoided as far as possible. Symmetrical sections are preferred.

The articles should be designed so as to assist the access and drainage of molten metal and so that air locks will be avoided.

Welding should be continuous on heavy sections but may be intermittent on sheet metal at least 2 mm thick. For thinner sheets, weld centres should be not greater than 100 mm and in certain circumstances continuous welding may be required.

7 Clearances

On mating surfaces, extra clearance should be provided to allow for the thickness of the coating metal. For zinc coatings on flat surfaces, an allowance of 1 mm will be ample, and for tin and tin-lead coatings 0.1 mm to 0.2 mm is usually sufficient.

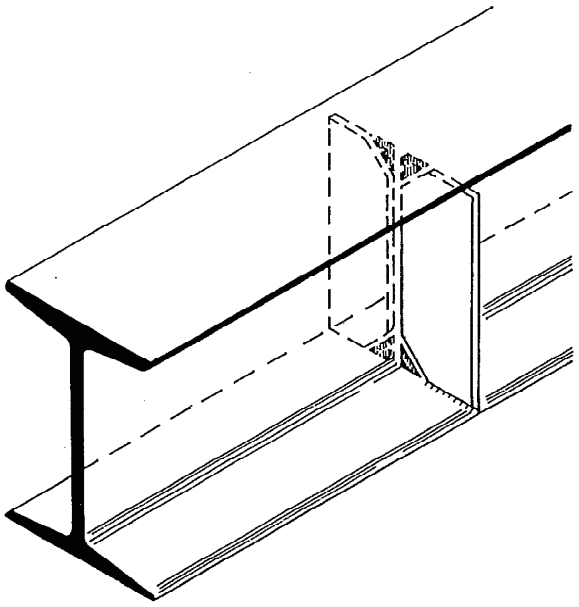
For threaded work, the situation is more complicated. For example, for hot-dip and centrifuged galvanized nuts and bolts the recommended practice is that the bolts are threaded to the tolerance laid down in the appropriate specification without allowance being made for galvanizing; the nuts are tapped up to 0.4 mm over size after galvanizing, and the threads are oiled. With tin or tin-lead coatings, fast centrifuging after hot-dipping will give coatings of only about 5 μm thickness on very small components which can therefore be of standard fit. Lead-tin coatings are more difficult to apply and tend to be thicker.

Hot-dip zinc coatings generally have thicknesses in the range 40 μm to 220 μm, while tin or tin-lead coatings generally are 2 μm to 8 μm thick. Above these ranges coatings become less uniform.

Appendix

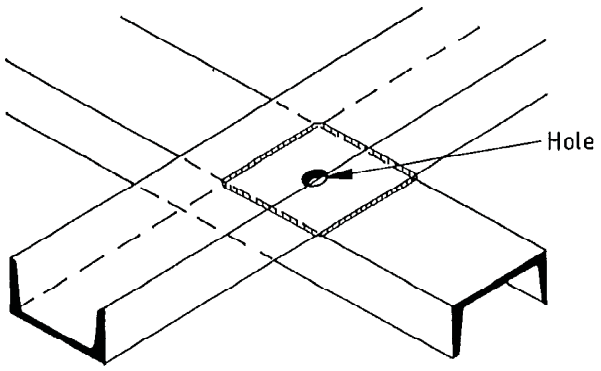
Appendix A. Diagrams illustrating preferred and deprecated design features for articles to be hot-dip coated

Diagrams illustrating preferred and deprecated design features for articles to be hot-dip coated are given in figures 1 to 12.

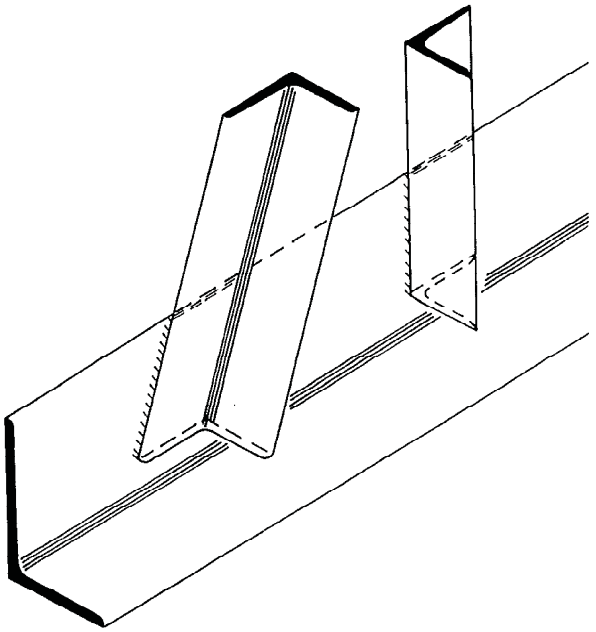


NOTE. External stiffeners should have their corners cropped.

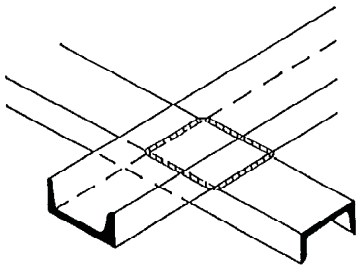
Figure 1. Beams



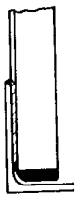
(a)



(c)



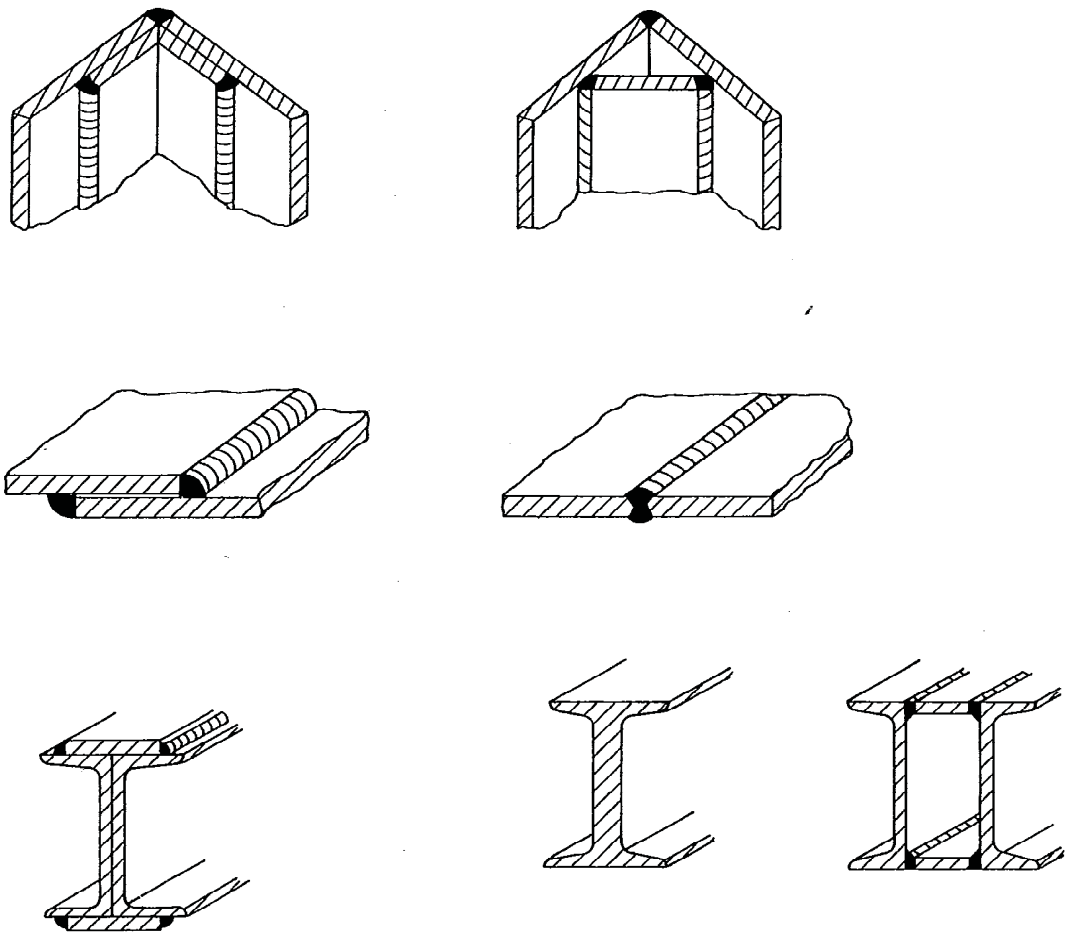
(b)



(d)

NOTE. For surfaces in contact, a hole should be drilled as indicated. If a hole is impracticable, the jointing should be intermittent. These precautions are necessary in order to avoid explosions. Angle bracings should, if possible, be stopped short of the main boom flange.

Figure 2. Jointing of beams

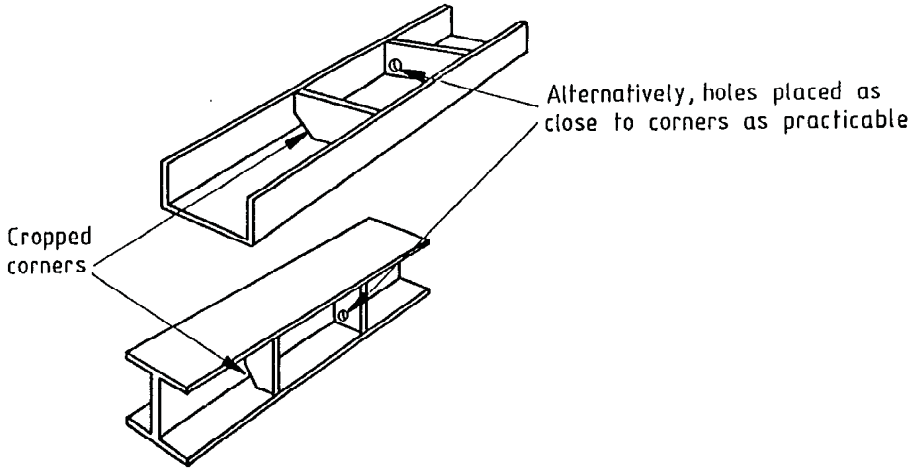


(a) Deprecated designs

(b) Preferred designs

NOTE. Narrow gaps between parts will allow liquid to penetrate but will not allow a hot-dip coating to be obtained between them. Welded or brazed joints should be continuous.

Figure 3. Narrow gaps

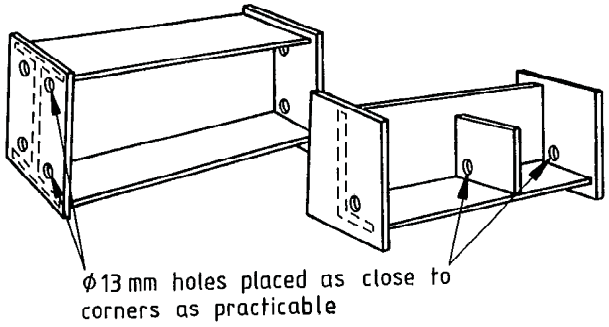


(a) Strengthening gussets and webs

NOTE. Welded strengthening gussets and webs on columns and beams, and strengthening gussets in members fabricated from channel sections should have corners cropped or holed for the following:

(1) to prevent the entrapment of air in pockets and corners allowing complete access of pickle acids and molten zinc to the entire surface of the work, and

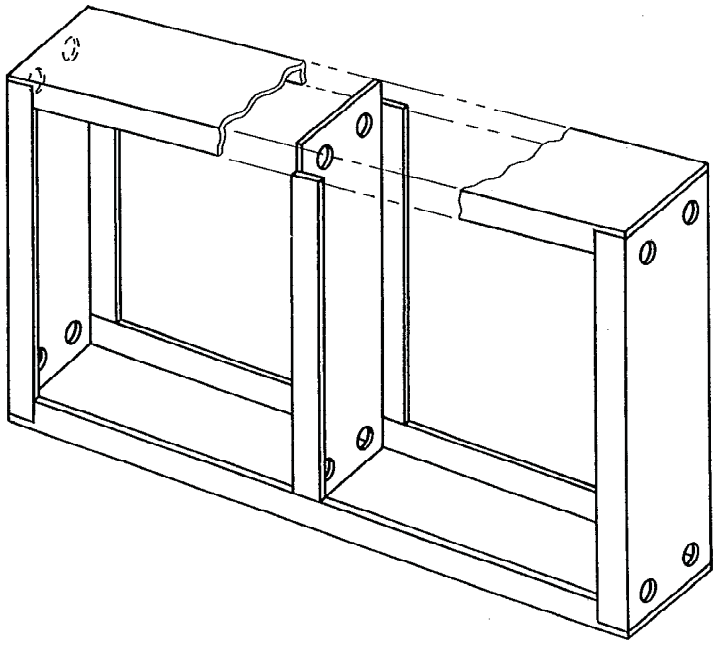
(2) to facilitate drainage during withdrawal from acid and rinse tanks, and from the galvanizing bath.



(b) End plates

NOTE. Holes at least 13 mm diameter should be provided in end plates on rolled steel shapes, to allow access of molten zinc in the galvanizing bath and drainage during withdrawal.

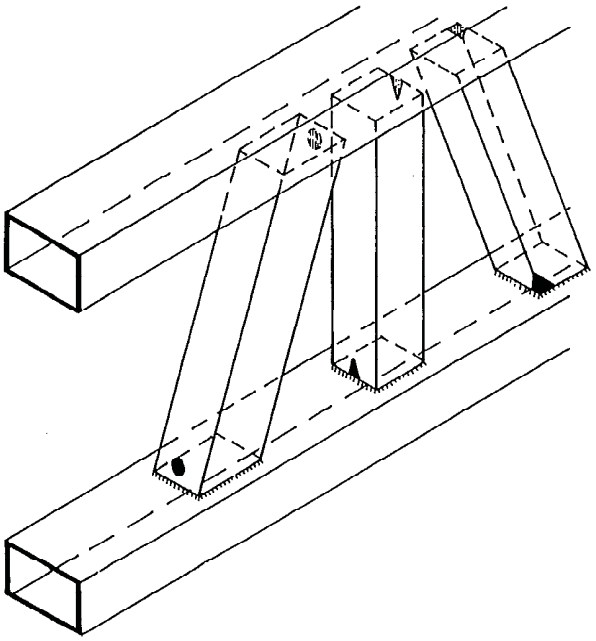
Figure 4. Strengthening gussets and webs, end plates and channel frames



(c) Typical channel frame

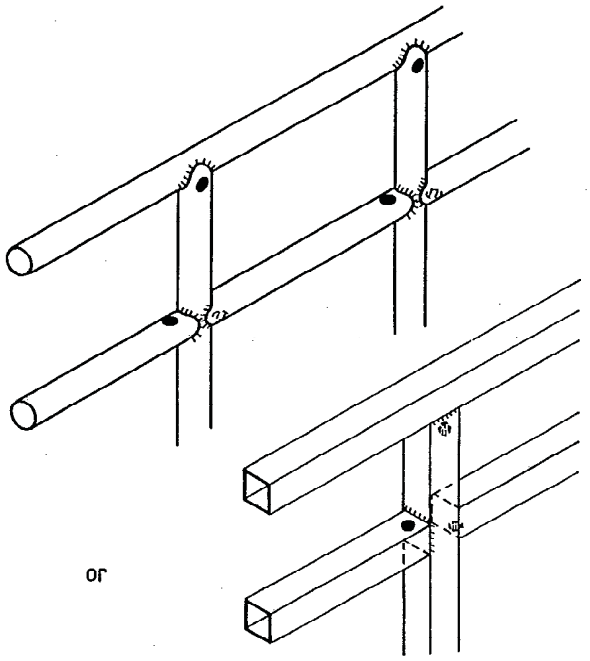
Important Consultation with the galvanizer may result in fewer holes.

Figure 4. Strengthening gussets and webs, end plates and channel frames



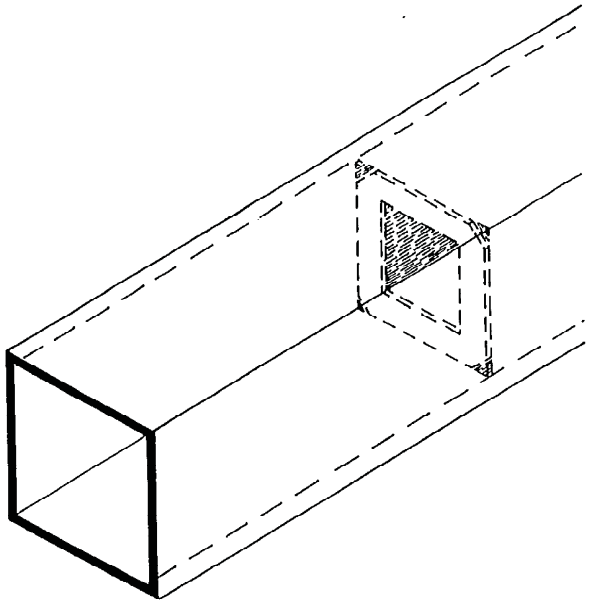
NOTE. Provision should be made for venting and draining. On vertical members drilled holes or V-notches should be provided diagonally opposite each other at top and bottom.

Figure 5. Structural hollow sections



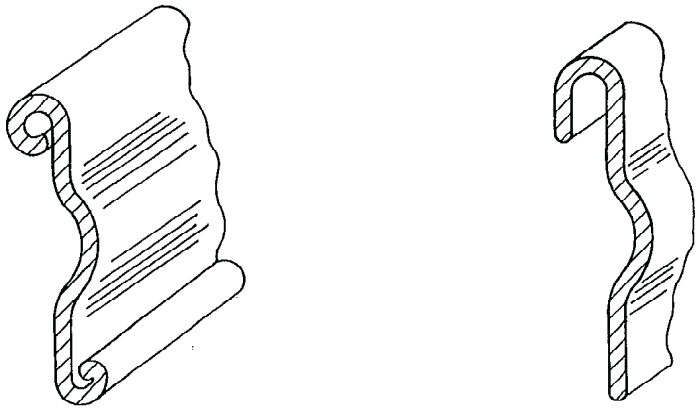
NOTE. Every section should be vented, preferably externally, for reasons of safety. Holes diagonally opposite each other should be as close as possible to the sealed end. The holes should be as large as possible and the minimum recommended size for small fabrications is 8 mm.

Figure 6. Tubular fabrications



NOTE. In large box sections internal diaphragms should have corners cropped and the centre cut away. In small box sections the corners of internal diaphragms should be cropped.

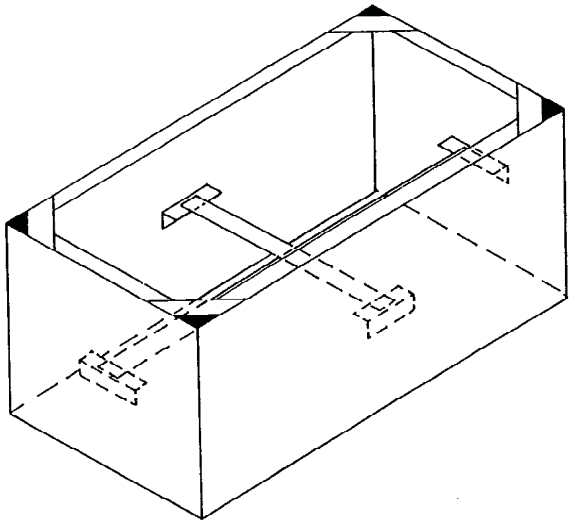
Figure 7. Internal diaphragms



(a) Deprecated design

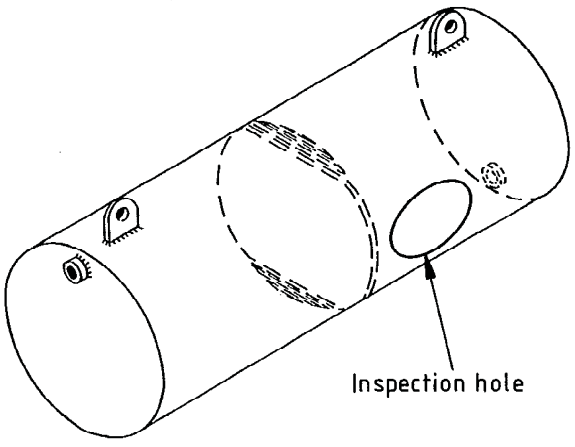
(b) Preferred design

Figure 8. Rolled edges



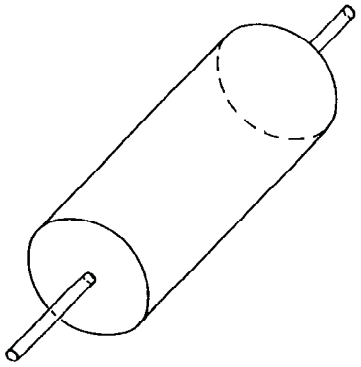
NOTE. Large open top tanks should be braced to minimize distortion. Where angles are used on the rim of the tank, apertures should be provided in the corners.

Figure 9. Open tanks

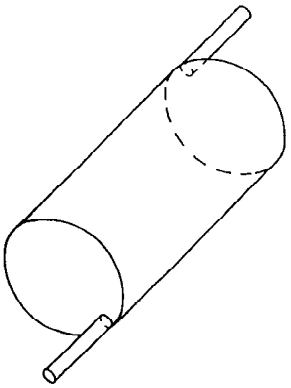


NOTE. Vents should be diametrically opposite and at least 50 mm in diameter. Internal baffles should be cropped top and bottom. It should be possible to view the baffles through an inspection hole or a manway. The galvanizer can give advice regarding the position and size of the inspection hole or the manway. Lifting lugs should be incorporated as shown.

Figure 10. Internal baffles



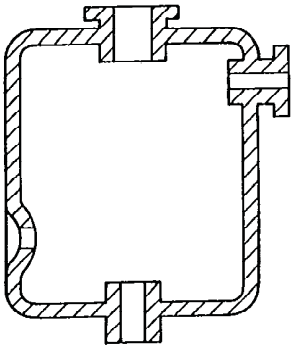
(a) Deprecated design



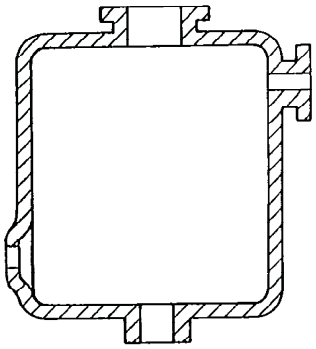
(b) Preferred design

NOTE. Pipe connections to hollow vessels should be arranged as close to the rim as possible to assist venting and draining.

Figure 11. Hollow vessels



(a) Deprecated design



(b) Preferred design

NOTE. Internal bosses should be avoided wherever possible. If not, an extra tapped hole should be included in the fabrication and this may be plugged after hot-dipping.

Figure 12. Enclosed cavities

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Publications referred to

CP 3012	Code of practice for cleaning and preparation of metal surfaces
BS 4479	Design of articles that are to be coated Part 1 General recommendations

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