



Design Guide for Hot Dip Galvanizing – best practice for venting and draining

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Venting and draining impacts on the safety of the galvanizing process as well as the quality and aesthetics of the coating

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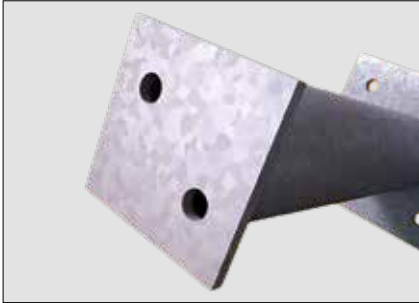
Introduction

It is important to consider the corrosion protection of ferrous articles when they are being designed. The key factors to consider when designing for hot dip galvanizing are the design's impact on:

- Safety during the process
- Quality of the coating
- Aesthetics

This guide provides general information on basic design and detailing practice, including venting and draining, with an aim to ensure articles are being hot dip galvanized safely and the quality of the coating is maximised.

Importance of Venting and Draining



Purpose

Formation of the hot dip galvanized coating occurs from the reaction of ferrous metal and molten zinc. The ferrous metal needs to have a clean, unoxidised surface for the molten zinc to react with it.

The purpose of venting and draining is to ensure the article can be immersed and withdrawn from each stage in the process in a safe, efficient and effective manner. Both the pre-treatment solutions (to clean the article) and the molten zinc must be able to flow freely into and around the article so contact is made with all surfaces and all air is displaced. In turn, the liquids must then be able to flow out of and run off the article.

Safety

Immersion of a sealed article into molten zinc will result in any trapped moisture becoming super-heated steam inside the article and will lead to an explosion (Figure 1). Any trapped pre-treatment fluid due to inadequate provisions for draining will expand rapidly when dipped in molten zinc and is also a significant safety risk.

Besides the considerable safety risks, trapped air due to an inadequately vented area of an article has two effects on galvanizing:

- 1) Will stop the pre-treatment solutions from cleaning that section of article and/or prevent zinc contacting the surface so the galvanized coating will not form, creating a bare spot.
- 2) Can cause the article to float in the zinc bath. Entrapped air can provide enough buoyant force that the article is difficult or impractical to immerse. See "Floating potential" section for more information.

Hence, vent holes need to be provided to allow air and moisture to escape from the article.



Figure 1: Purpose of Venting and Draining

Quality

When venting and draining is an afterthought instead of part of an article's design, this not only impacts on its ability to be galvanized, but on the quality outcome.

The size of holes for venting and draining, as well as their placement, has an impact on immersion and withdrawal.

Trapped air and fluid, as well as being a safety concern, can cause quality issues (for example, bare spots on the surface). Larger holes allow faster flow of zinc in and out of the article, making immersion and withdrawal easier. This results in a better quality finish.

The density and viscosity of molten zinc are important factors to consider when allowing for adequate drainage from articles. Drilled and/or smoothed pre-cut holes are strongly preferred to help optimise the zinc flow. Flame-cut holes or holes made with an oxy-cutting torch will be rougher, which disturbs the flow of the zinc and can sometimes have noticeably slower flow rates or cause a different type of flow. Moreover, a rough edge makes measuring the hole size more difficult which often results in undersized holes.

Slow flowing zinc from inadequate holes tends to produce unsightly zinc runs and pimples.



Inadequate venting and draining of steel with a more reactive chemistry will grow thicker, duller and more brittle coatings, leaving the coating prone to flaking, if the article can only be immersed and withdrawn slowly from the bath.

If the molten zinc is not readily drained from in or around the article, it may become excessive dead weight on the article or the lifting equipment. This can cause dimensional instability for thin walled hollow vessels (e.g. tanks).

Aesthetics

Factors affecting the quality of the hot dip galvanized coating may also impact on aesthetics.

Hole placement for venting and draining may be an aesthetic issue and should be addressed at the design stage of the article. For example, the choice of hollow or open structural sections will effect the amount, type and location of venting and draining needed in order for the article to be safely galvanized.

The shape of holes should also be considered, as wide and short holes will allow greater flow rates, increasing potential quality and decreasing the possibility of floating. However, if sealing holes after galvanizing is desired round holes will be easier to fill.

The availability of good hanging points for the article is another factor that will improve aesthetics.

Any specific requirements with regards to aesthetics should be discussed with the galvanizer during the design stage or prior to fabrication.

General Principles



Hanging and Handling

Facilities exist to galvanize components of virtually any size and shape, depending on handling equipment and layout of the galvanizing plant.

Most articles to be hot dip galvanized will be suspended from a jig and/or overhead crane using wires, chains, brackets or hooks while being processed.

The maximum size and weight that a particular galvanizer can process should always be checked at the design stage.

Adequate hanging points should be provided, e.g. suspension holes or lugs, taking into consideration article size and the lifting capacity of equipment.

For long, straight sections, 2 lifting lugs are preferred to avoid wire or chain marks.

Where possible, articles are hung on a 45° angle (approximately) to ensure efficient drainage of pre-treatment solutions and molten zinc. This avoids rough surfaces and lets the air escape from the highest point, preventing explosions.

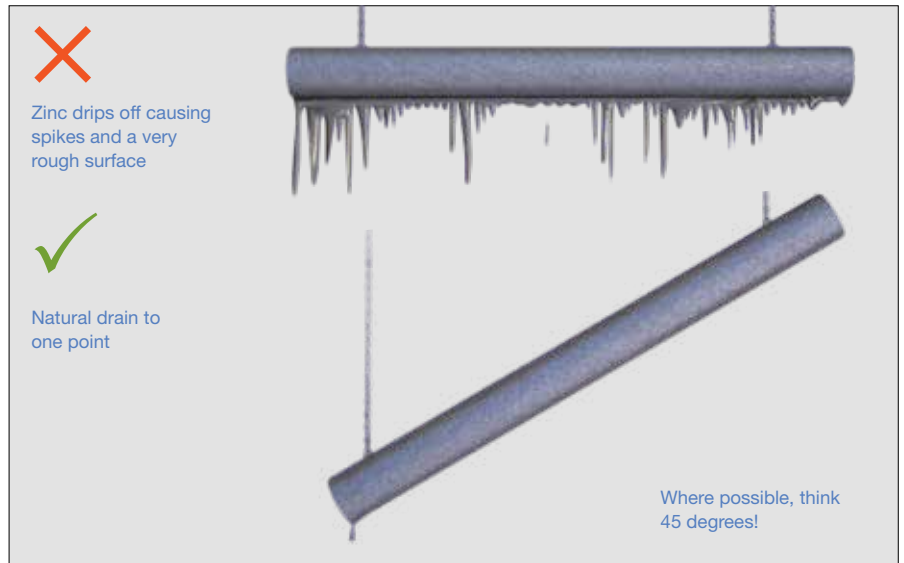


Figure 2: Hanging for Drainage Quality

Long items will often be withdrawn from the bath at a shallow angle to avoid the lower submerged end from touching the bottom of the kettle. A shallow withdrawal angle causes the zinc to flow off at a slower rate leading to a heavier zinc layer on the top surface and greater quantities of ash trapped on the bottom surface of the steel article.

Small items such as fasteners, nuts and brackets may be placed into baskets rather than hung. See '*Centrifuging process*' for more information.

Items longer or deeper than the bath size may be galvanized by using a double-dipping method. See '*Double dipping process*' for more information. In these cases, material handling considerations will impact on cost. A better method may be to use bolted connections or modules for assembling post galvanizing.

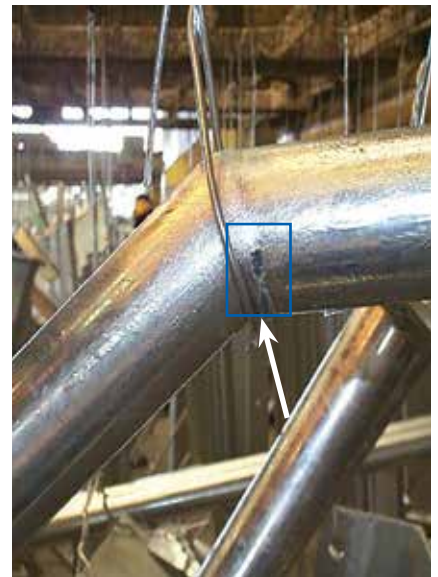
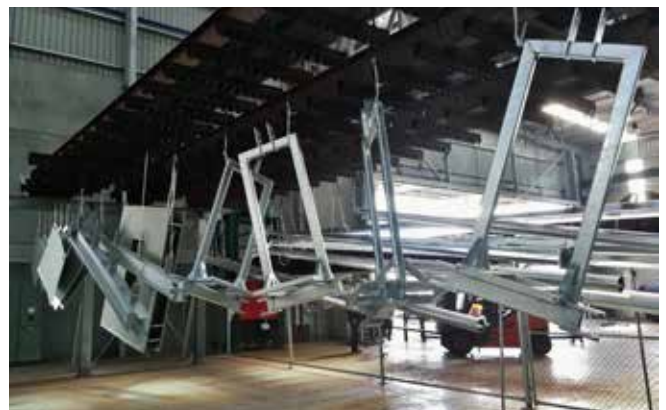


Figure 3: Touch marks may not be avoidable with chains and wires



Hole Position

The location of the vent and drain holes shall be determined by the shape of the fabrication and the angle at which it is suspended for galvanizing, as well as the enclosed volume of zinc in the fabrication when draining. A good rule of thumb for the designer is to think of items being lowered into and lifted from the galvanizing bath at an approximate 45° angle as discussed in Figure 2.

- Holes should be placed as close to corners and/or connections as practical.
- Holes must be located as close to the high and low points of hollow sections as possible to prevent air locks, entrapment of pre-treatment chemicals and zinc puddling.
- Holes should be orientated in the same plane as the fabrication.
- Holes **must not** only be located in the centre of end plates and connections.
- Holes should be diagonally opposed where possible.



Hole Size

Dimensions of holes shall be determined by the trapped volume of air in the fabrication and the surface area of the steel in the vented area. Each square metre of steel surface produces approximately 200g of zinc ash, which must be able to escape through the holes.

- Minimum hole size is $\phi 10\text{mm}$
- Hole diameters should be at least the same size as the steel thickness.
- Having bigger holes (where feasible) is always better for the galvanizing outcome.

Refer to '*Hollow Sections*' for applicable hole size charts.

Refer to '*Hollow Vessels*' for applicable hole size chart.

The size of the holes for venting and draining impact significantly on fill and drain times of an article. An increased hole size will improve flow rates for filling and draining the articles.

Other factors that affect zinc flow rates, and in-turn fill and drainage rates, include the shape of the holes and the shape of any hollow sections. Wide and short holes allow greater flow rates and circular products fill and drain more quickly than square or rectangular products of equivalent size.

Floating Potential

Key factors that influence the ability for articles to be immersed and withdrawn safely from the molten zinc are:

- The position and size of vent and draining holes. Increased hole sizes improve the flow rates to fill and drain the article.
- Article dimensions (length, width, and height or length and diameter). The larger the article, the more zinc in the bath that must be displaced by the article and flow around/within it. The more volume needed to be displaced, the greater buoyant force that works on the article.
- The hanging position or dip angle, along with the article dimensions, determines the lifting height during immersion, and therefore the distance molten zinc needs to move vertically up the article.

If too much air remains in the article during immersion in the kettle due to poor placement and/or under sizing of vent/drain holes relative to the article size, the entrapped air can provide enough of a buoyant force to cause floating, making the article difficult or impractical to immerse.

The percentage of air that needs to be entrapped in the article to cause floating in a zinc bath decreases greatly as the size of the article increases and is only a small percentage of a considerably large article's volume. It is important to emphasise that this floating potential is related to the zinc bath, which will have a much greater buoyant force working on the article than the water-based pre-treatment solutions. This means that issues of air entrapment are unlikely to become apparent until the article is being dipped into the molten zinc, if at all.

This means smaller hollow sections pose a much greater safety risk to a galvanizer. A small amount of air and/or liquid trapped within a small section volume will not provide enough buoyancy effect to prevent the article from being fully immersed in the molten zinc. When immersed, any trapped moisture will then be vaporised and could create enough pressure to lead to an explosion.



Size and Weight

i. Centrifuge process

Small items are placed into a basket to be dipped and centrifuged. The size of baskets, centrifuges and other equipment will vary, just like general galvanizing baths.

Typically this process involves all the same stages as the general galvanizing process with the added centrifuging (or spinning) stage that occurs after withdrawal from the molten zinc. The centrifuging (or spinning) removes the excess zinc from the small articles, including from any threads or holes.

The coating thickness and mass requirements differ from other batch galvanized pieces due to the spinning process removing excess zinc.

Note: Not all galvanizers have centrifuge facilities and not all small items will be galvanized via the centrifuge process.



Typically this process involves all the same stages as the general galvanizing process with the added centrifuging (or spinning) stage

ii. Double dipping process

Double dipping is a term used to describe the process of galvanizing an item which is longer, wider or deeper than the relevant available bath dimensions. In this procedure, the item is lowered into the bath so that half or more of its 'over dimension' is immersed in the molten zinc.

When the galvanized coating has been achieved on the immersed section, the item is withdrawn from the bath and adjusted in handling so that the ungalvanized portion can be immersed in the molten zinc.

In the double dipping procedure an overlap of zinc coating will occur and this will normally have to be addressed in the case of visually obvious structural elements, in particular any requirements for architecturally exposed structural steelwork should be identified prior to order. In addition, double dipping increases the possibility of distortion (dimensional instability) of fabricated items. Guidance in these cases should be sought from the galvanizer.



Distortion (Dimensional Stability)



When steel sections or fabrications are immersed in molten zinc, their temperature is raised to that of the molten zinc, which is typically 450°C. The rate at which the steel reaches this temperature across its entire surface will depend on:

- the thickness of the individual sections making up the item,
- the total mass of the item,
- the dimension of the item, and
- speed of immersion.

At galvanizing temperatures, there is no change to structural steel's metallurgical microstructure and the process is not hot enough to have any heat treating effects on the mechanical properties of most structural steels after galvanizing.

However, at galvanizing temperatures, the yield strength of steel is temporarily lowered by approximately 50%. If any attached steel is not at the same temperature and any stresses exist, the weaker area will be subject to movement by the stronger area. There is a responsibility on the designer, the fabricator and the galvanizer to co-operate in ensuring distortion risks are minimised or eliminated.



Basic design rules for avoiding distortion

- 1) Maximise the uniformity of heat transfer into and out of the steel.
 - a. Ensure venting and draining is adequate. This will allow the article to be immersed in and withdrawn from the molten zinc as quickly as possible.
 - b. Minimise section thickness variations wherever possible in the fabrication.
- 2) Minimise the effect of stresses while the article is in the molten zinc.
 - a. Use symmetrically rolled sections in preference to angle or channel frames. I-beams are preferred to angles or channels.
 - b. Ensure assembly and welding techniques minimise stresses in components making up the article.
 - i. If cutting plate to size, ensure all sides are cut using the same technique. Guillotine is the preferred cutting technique.
 - ii. Bend members to the largest acceptable radii to minimize local stress concentration.
 - iii. Accurately pre-form members of an assembly so it is not necessary to force, spring or bend them into position during joining.
 - iv. Continuously weld joints using balanced welding techniques to reduce uneven thermal stresses.
 - v. Staggered welding techniques to produce a structural weld are acceptable.
 - vi. For staggered welding of material 4mm or less, weld centres should be closer than 100mm.
- 3) Avoid designs that require double dipping. It is preferable to build assemblies and sub-assemblies in suitable modules allowing for quick immersion and galvanized in a single dip so the entire article can expand and contract uniformly.
- 4) Ensure the structural design of the item is sufficient to support its own weight at 50% of the steel's specified yield strength.
- 5) Avoid using large areas of thin (under 8mm), unbraced flat plate.
- 6) Use temporary bracing or reinforcing on thin-walled and asymmetrical designs.

Risk of distortion for various items

Low risk: All hot rolled structural sections, fabrications containing angles, channels and universal hot rolled sections, tube and RHS sections and fabrications, ribbed or corrugated plate sections, grating, and heavy plate (over 16mm).

Medium risk: Light section roll formed products, long light walled conduit and tubing, fabrications containing asymmetrical weldments or steel of significantly different thickness, medium plate (8-16mm), and some double dipped items.

High risk: Thin sheet and plate (under 8mm depending on shape, area and bracing), floor-plate, deep plate web girders, platforms containing floor-plate, long channel sections with multiple weldments (cleats) on one side of web.

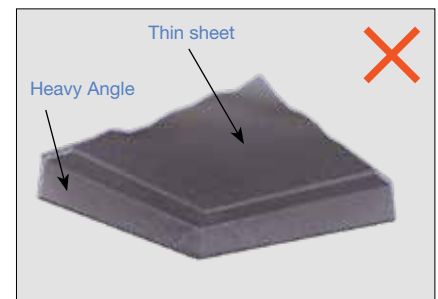


Figure 4: Thick + Thin = Distortion



Figure 5: Avoid Distortion with Good Design



Structural Sections



Hollow Sections

Basic venting and draining rules for hollow sections

Size of holes

- Holes shall be appropriately sized for the size of the section to be galvanized. See Table 1 to Table 3 for the minimum recommendations for standard hollow sections.
- Vent holes shall be at least 10mm in diameter or the same thickness as the steel section, whichever is larger.
- The length of the hollow section and if it is part of a larger fabrication should also be taken into consideration for the required hole size.
- Large hollow vessels require a vent and drain hole for every 0.5m³ of enclosed volume, each being a minimum of 50mm in diameter. See Table 4.
- Hollow sections (pipe/CHS, RHS and SHS) require vent and drain holes, each with a diameter equivalent to at least 25% of their diagonal cross section length or multiple holes (for both venting and draining) of equivalent minimum cross sectional area.
- The preferred design option (Open Ends Preferred A in Figure 7) is to leave the ends of hollow sections completely open. This will improve the aesthetic quality of the fabrication.
- Where open ends cannot be provided, the provision of at least two holes positioned opposite each other. (as shown in Figure 7 and the Preferred B option in Figure 8)
- Holes only located in the centre of a hollow section, as shown in Figure 7 and 8, are unacceptable and will result in poor quality outcomes. Acceptable use of a centre hole is shown in the photo above.

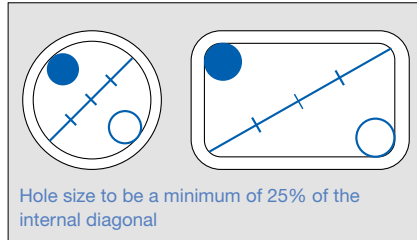


Figure 6: Diagonal Cross Sections



Location of holes

- Vent and drain holes shall be located as close as possible to the high and low points of the hollow section when hung to prevent air locks, entrapment of pre-treatment solutions and zinc pooling as well as being oriented in the same plane as the fabrication (Figure 7).
- Holes **must not** only be located in the centre of end plates and connections. This will cause cleaning fluids to be trapped and result in uncoated surfaces inside the plate or connection as well as potential 'blowouts' where the cleaning fluids are expelled from the hole under pressure creating bare spots on the finished article. On withdrawal from the galvanizing bath, centre only located holes will trap zinc (Figure 7).
- Hollow sections connected together require external vent and drain holes as close to the connection as possible. Internal venting may also be used to ensure pre-treatment solutions and zinc can flow freely through the sections and steam generated from any liquids remaining inside the sections can be efficiently vented. For more information on internal venting, see 'Using Hollow Section'.

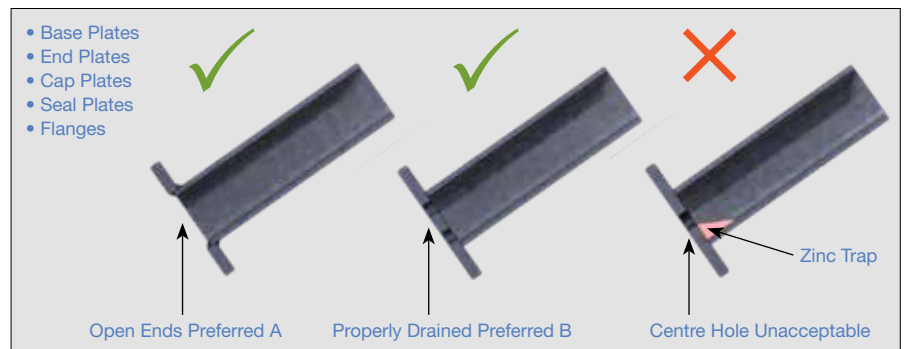


Figure 7: Hollow Section Ends - Inside View

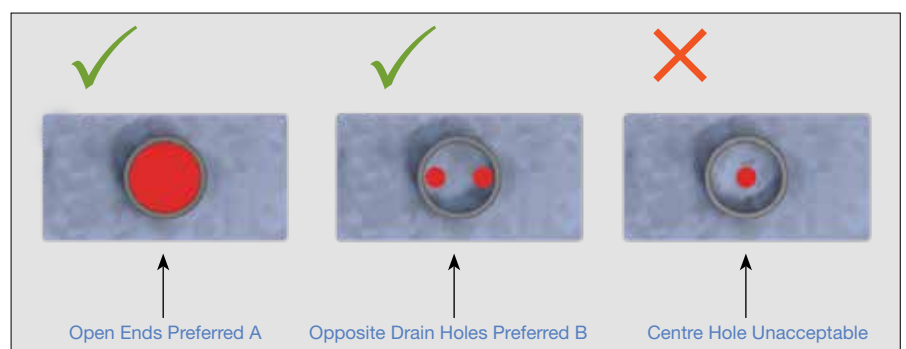


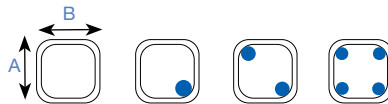
Figure 8: End Plates for Hollow Sections

Table 1: Standard Holes Sizes for CHS/Pipe



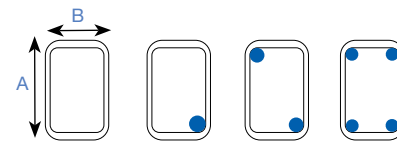
NB	Outside Diameter Ø (mm)	1 Hole Ø (mm)	2 Holes Ø (mm)	4 Holes Ø (mm)
20	26.9	10	10	10
25	33.7	10	10	10
32	42.4	11	10	10
40	48.3	12	10	10
50	60.3	15	11	10
65	76.1	19	13	10
80	88.9	22	16	11
90	101.6	25	18	13
100	114.4	30	20	14
125	139.7	35	25	17
150	165.1	45	30	22
	168.3	45	30	22
	219.1	55	40	30
	273.1	70	50	35
	323.9	85	60	40
	355.6	90	65	45
	406.4	105	75	55
	457	115	85	60
	508	130	90	65

Table 2: Standard Holes Sizes for SHS



A x B (mm)	1 Hole Ø (mm)	2 Holes Ø (mm)	4 Holes Ø (mm)
20 x 20	10	10	10
25 x 25	10	10	10
30 x 30	11	10	10
35 x 35	12	10	10
40 x 40	14	10	10
50 x 50	18	13	10
65 x 65	25	16	11
75 x 75	25	19	13
89 x 89	35	22	16
90 x 90	35	25	16
100 x 100	35	25	18
125 x 125	45	35	22
150 x 150	55	40	30
200 x 200	75	50	35
250 x 250	90	65	45
300 x 300	110	75	55
350 x 350	125	90	65
400 x 400	145	100	75

Table 3: Standard Holes Sizes for RHS



A x B (mm)	1 Hole Ø (mm)	2 Holes Ø (mm)	4 Holes Ø (mm)
50 x 25	14	10	10
65 x 35	18	13	10
75 x 25	20	14	10
75 x 50	25	16	11
100 x 50	30	20	14
125 x 75	40	30	18
150 x 50	40	30	20
150 x 100	45	35	25
200 x 100	60	40	30
250 x 150	75	55	40
300 x 200	90	65	45
350 x 250	110	80	55
400 x 200	115	80	60
400 x 300	125	90	65

Note: '1 hole', '2 holes' and '4 holes' means the number of holes in each otherwise unopen end.

Hot Rolled Sections



- End plates, gussets and stiffeners all restrict drainage. Vent and drain holes or openings (e.g. snipes) need to be provided in the corners of connected structural member (Figure 9 and Figure 10).
- The corners of end plates, gussets and stiffeners can also be cropped (referred to in industry as 'snipes') to allow for venting and draining (Figure 9 and Figure 10).
- See the Snipe Guide (Figure 11) for the recommended snipe sizes for various structural members.

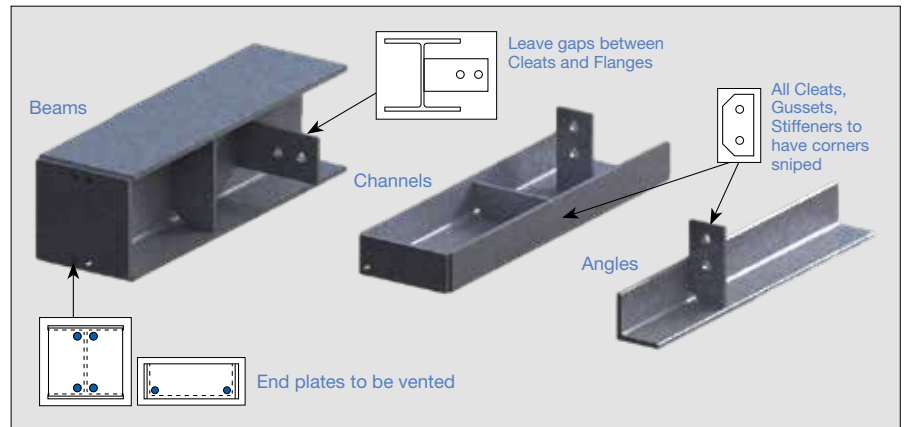


Figure 9: Hot Rolled Profiles – Typical Designs

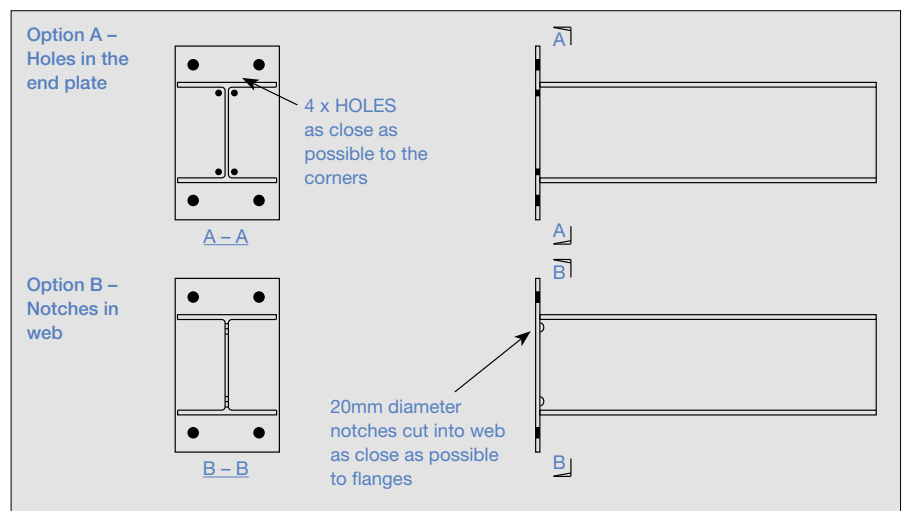


Figure 10: End Plates Options

	Nominal Section	Snipe Size (mm)
	PFC	
	150 to 250	25x25
	above 250	30x30
	Angle	
	100 to 150	25x25
	above 150	30x30
	UB	
	up to 250	25x25
	above 250	30x30
	UC	
	up to 200	25x25
	above 200	30x30
	(For the smaller sections, a hole is the more preferred option for venting.)	

Figure 11: Snipe Guide



Figure 12: Snipe Gussets

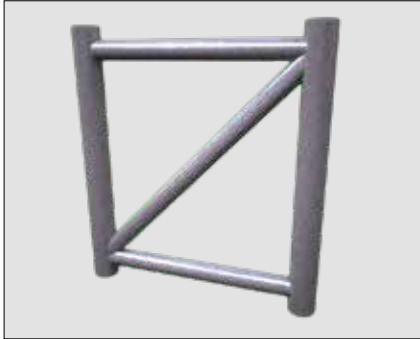


Figure 13: Design Orientation



For safety reasons, a galvanizer must be able to verify that any internal venting has been completed

Frames and Fabrications



Design details are important when fabricated articles are to be hot dip galvanized.

Figure 14 to Figure 24 show basic design practices to ensure articles are able to be successfully galvanized and a quality hot dip galvanized coating is achieved, while others may need a significant amount of venting and draining. Generally, the more complex the hollow fabrication, the longer the immersion and withdrawal time due to the need for changes in the flow direction (e.g., corners or tees) or changes in the cross-sectional area (e.g., diameter) the zinc flows through. In these cases, more or larger holes than the minimum recommendations should be considered to help increase flow rates, allowing decreased dipping times and better quality.

Some designs can provide adequate natural drainage without requiring holes (Figure 24).

Using Hollow Sections

External holes

- External holes are needed to ensure quick visual inspection and verification that work is safe to galvanize.
- Each member should have two holes in each end orientated in the plane of the fabrication.
- External holes are to be placed as close to the connection as possible.
- External holes size determined by 25% of the cross section. See 'Standard Hole Size Tables'.

Internal holes

- Internal vent holes must be at least 50% of the connecting section. It is recommended they be the same size as the internal diameter of the connecting section where practical. See Figures 14 and 18.
- Internal venting must be shown on shop detail drawings and be approved by the galvanizer prior to fabrication. This method of venting is also recommended to be approved by the structural engineer.
- Internal holes must be visible or be able to be otherwise proven to be satisfactorily formed for inspection purposes.
- A Ø10mm external check hole must be included at each location where internal venting is specified on the shop detail drawings. This best practice requirement will allow the galvanizer to safely proceed with dipping the article.

See 'Location of holes' and 'Size of holes' for more information.

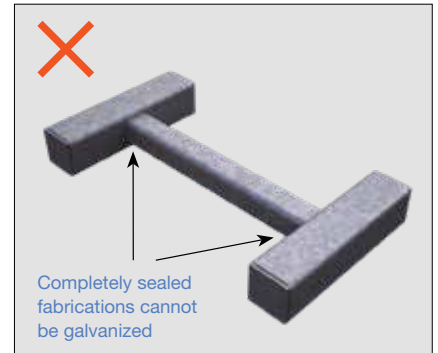


Figure 14: Closed Hollow Sections – Unsatisfactory



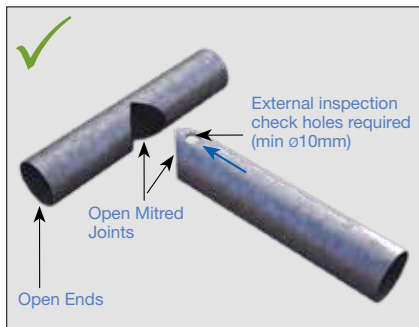


Figure 15: Mitred Joints – Preferred

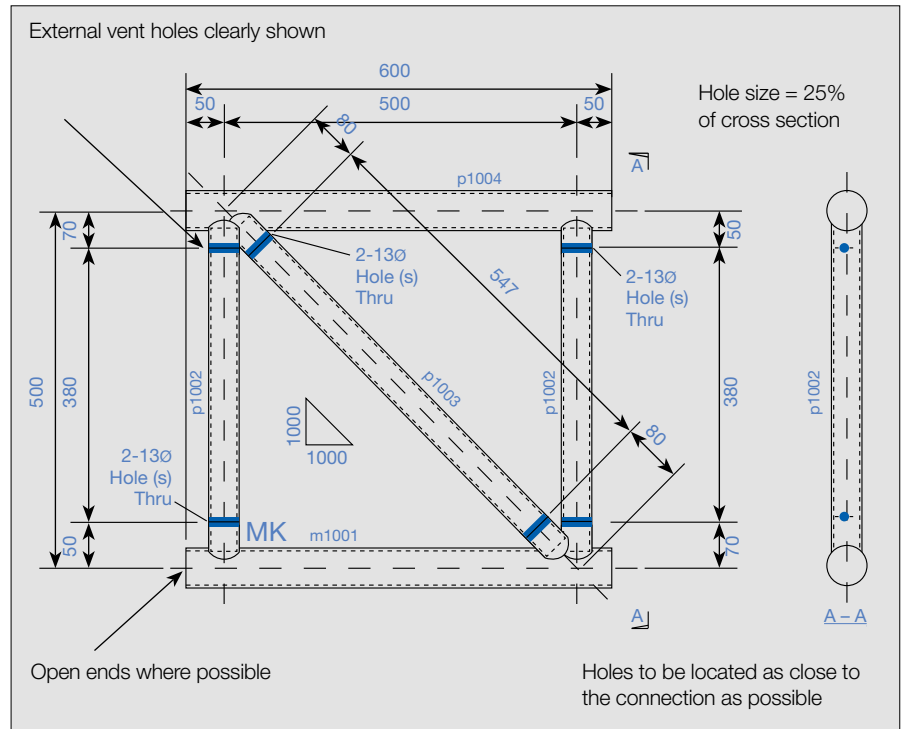


Figure 16: External Venting Shop Detail – Preferred

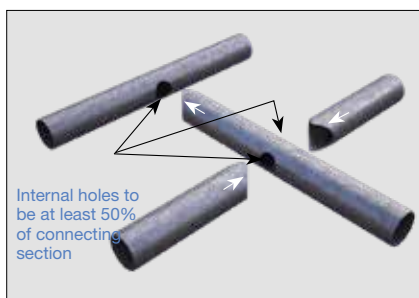


Figure 17: Internal Vent Holes with No Inspection Holes – Non-Preferred

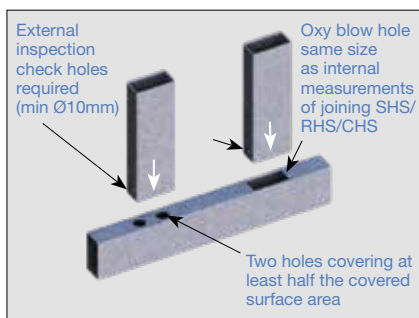


Figure 18: Internal Vent Holes – Drawing to clearly show items are “Internally Vented” with Inspection Holes - Preferred

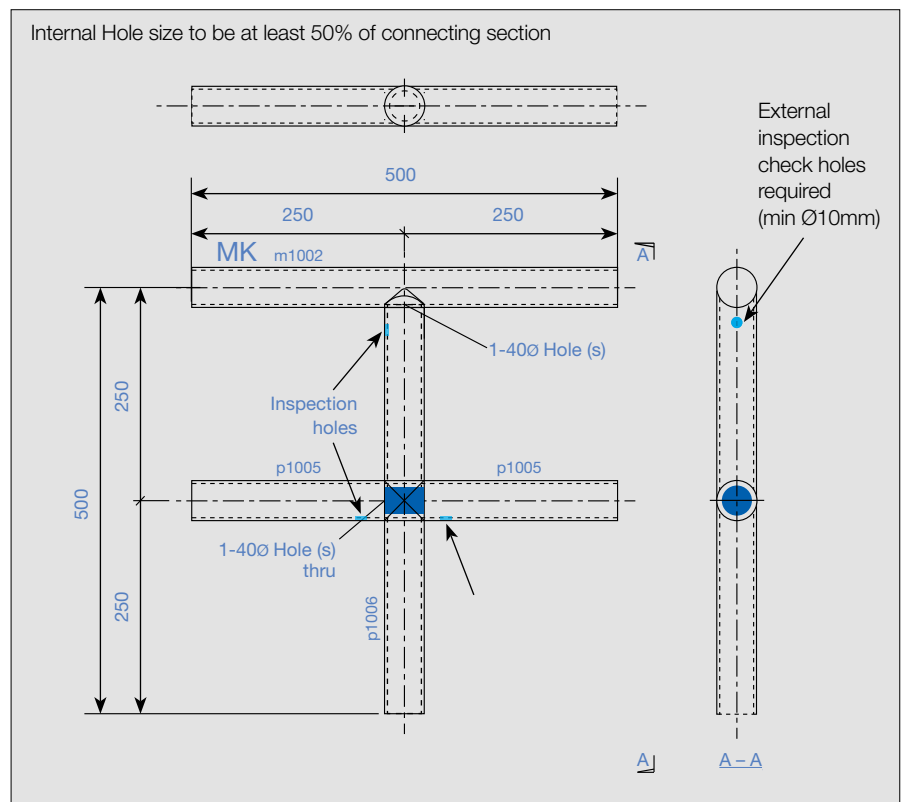
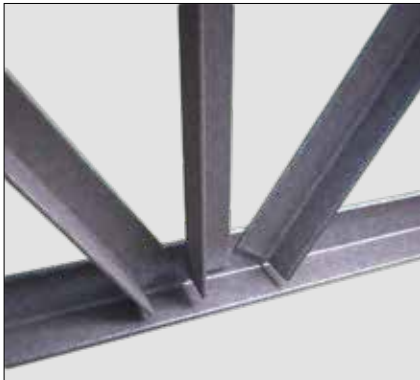


Figure 19: Internal Venting Shop Detail

Using Other Structural Sections



Basic guidance on design, venting and draining for fabricated frames or articles using structural sections are given in Figures 20 through 24.

The same design principles related to 'Hot Rolled Sections' should also be applied to the use of these sections in frames and general fabrications.

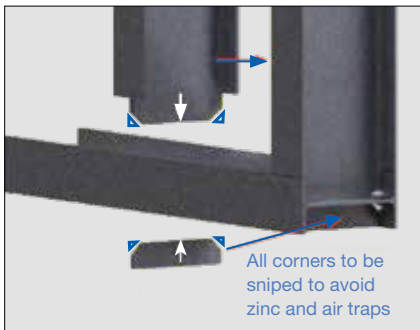


Figure 20: Venting Hot Rolled Frames

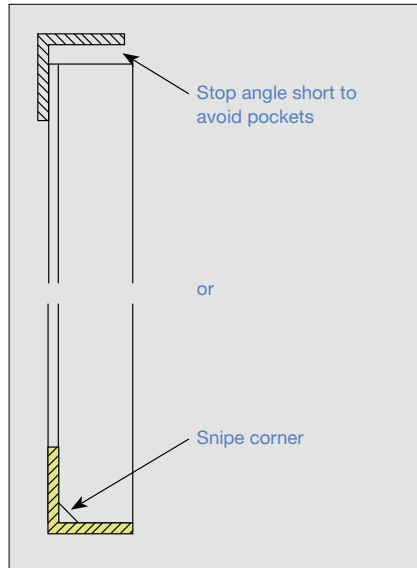


Figure 21: Angle Connections Options

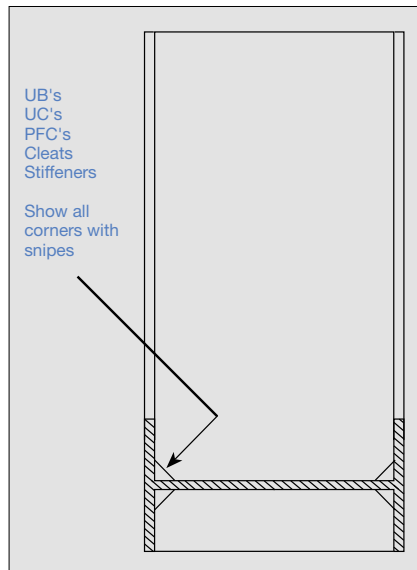


Figure 22: Vented Frame

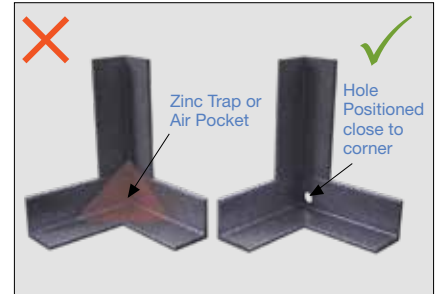


Figure 23: Inward Facing Angles – Venting Required



Figure 24: Outward Facing Sections – Preferred



Base plates and end plates welded to hollow sections require venting to allow pre-treatment fluids, zinc and air to escape during the galvanizing process.

Handrails/Balustrades



There is a large variety of handrail and balustrade designs. Handrail may be galvanized in panels or individual parts prior to assembling.

Handrails constructed with hollow sections will require specific attention to detail for the highest quality galvanizing outcomes. Figures 26 show the typical detailing and hole positioning required for standard designs.

Designs which will provide the highest quality HDG finish are:

- Modules within a single plane (straight sections).
- Modular designs that can be bolted together on-site.
- Large vent and drain holes in the hollow sections which will allow the zinc to flow freely and air to escape from inside the article.
- Internal venting of all rail portions inside a stanchion is required if the rail runs continuously through the stanchion.

Figures 25 and 26 offer best practice guidance on hole placement for modular straight sections of handrails, which will also provide the galvanizer with more options for hanging the article.

For designs where a higher quality finish of the handrail are essential, for example where touch marks and runs or spikes on visual surfaces are minimised, hanging, venting and draining requirements should be agreed with the galvanizer prior to fabrication.

Designs which will need special consideration to provide the highest quality HDG finish are:

- Handrails with multiple planes (corner or bent sections) so that some parts of the handrail vent and drain slower than others parts within the same handrail. This can affect available hanging angles due to both vent and drain designs and bath size restrictions which could reduce coating quality.
- Vent and drain holes that are internal will need to be verified through the use of external inspection holes.

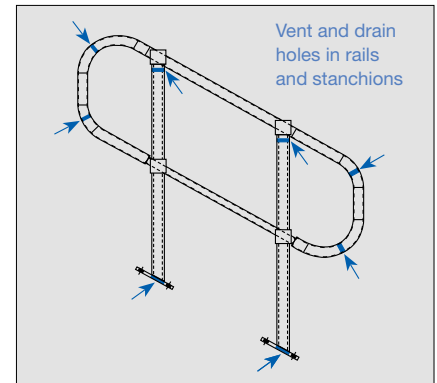


Figure 25: Handrail Hole Positions

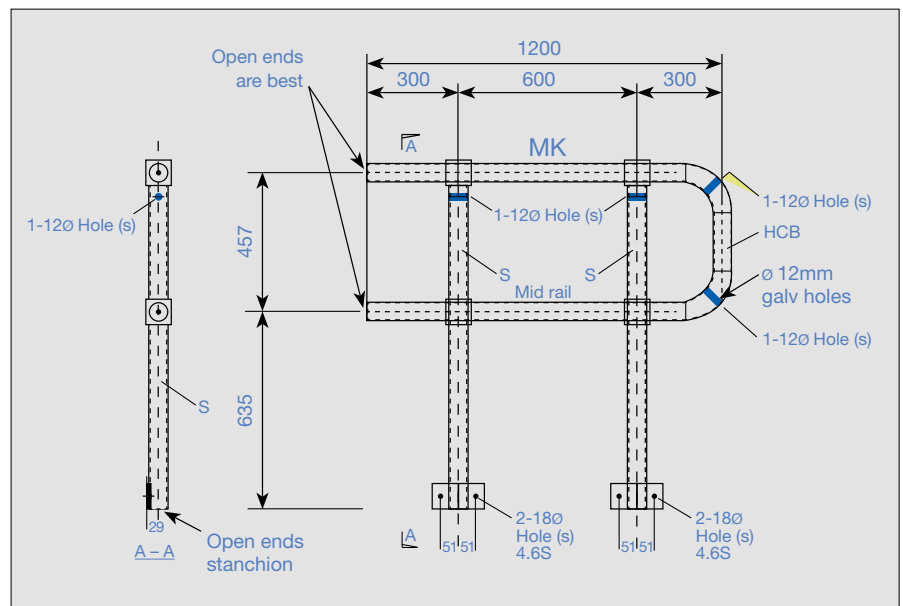


Figure 26: Handrail Detail



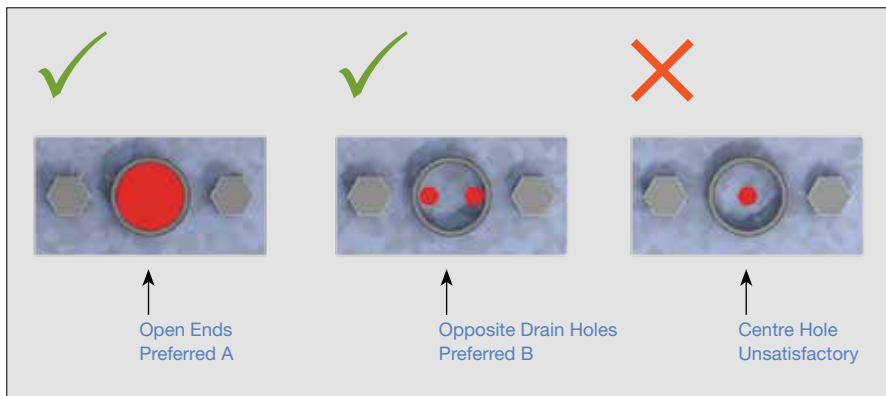


Figure 27: Stanchion Base Plates



Hollow Vessels



- Hollow vessels may require temporary stays during the galvanizing process to prevent distortion
- Hollow vessels should have at least 1 vent hole and 1 drain hole
- Standard minimum venting and draining for an enclosed volume is a 50mm diameter hole for each 0.5m³ (see Table 4)
- Openings should finish flush inside the vessel
- Baffles inside vessels should have openings to allow free flow of liquid throughout. A minimum of 75mm snipes is required. See Figures 8 to 11 for more information on snipes.

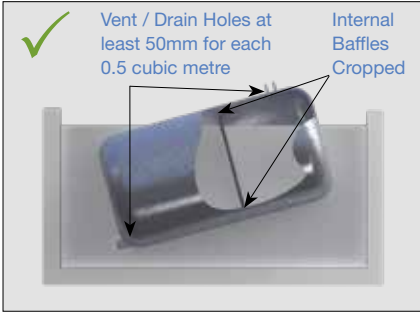


Figure 28: Hollow Vessels – Good Design

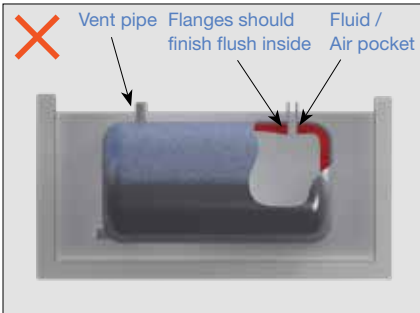


Figure 29: Hollow Vessels – Bad Design



Table 4: Minimum hole sizes for hollow vessels

Section Volume (litres)	1 Hole Ø (mm)	2 Holes Ø (mm)	4 Holes Ø (mm)
500	50	35	25
1000	70	50	35
1500	90	65	45
2000	100	70	50
2500	115	80	55
3000	125	90	65
3500	135	95	70
4000	145	100	70
4500	150	110	75
5000	160	115	80
5500	165	120	85
6000	175	125	90
6500	180	130	90
7000	190	135	95
7500	195	140	100
8000	200	145	100
8500	210	145	105
9000	215	150	110
9500	220	155	110
10000	225	160	115

Overlapping Surfaces



Large, seal welded overlapping surfaces require venting in the form of a hole(s) drilled in one of the overlapping surfaces.

An enclosed area between overlapping surfaces may contain condensation or the welds may contain pin holes that will allow pre-treatment solutions to enter the enclosed area during the galvanizing process. This is unsafe when the articles are heated to 450°C in the molten zinc.

- Overlapping surfaces can be particularly dangerous if not designed correctly for galvanizing, so communication with the galvanizer is essential to ensure the correct venting is provided.
- Avoid narrow gaps between plates, overlapping surfaces, and back to back angles and channels, as fluid may get trapped leading to the possibility of an explosion or later corrosion of uncoated overlapped surfaces. See 'For intermittent weld design' for more information.

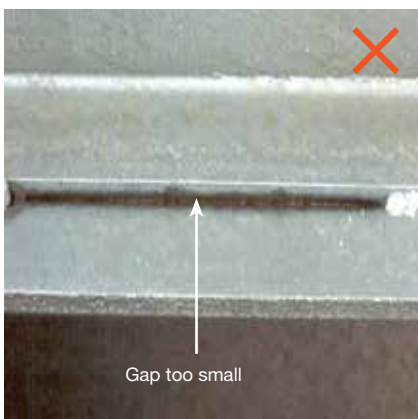


Figure 30: Overlapping Areas - Venting Unsatisfactory

When overlaps are unavoidable:

- Seal edges using pinhole-free continuous welding and provide 2 vent holes for best outcomes.
- Pinholes from welding are very dangerous in articles to be galvanized and must be avoided.
- Size of the hole(s) should be equal to or greater than the steel thickness, with the minimum being 10mm.
- Avoid gaps between members or have at least a **2.5mm** gap and stitch weld so all the surfaces can be galvanized. In this case, additional vent holes would not be required (see 'For intermittent weld design').
- Intermediate sized overlaps should be judged on the basis of weld integrity and residual welding heat in the joint to ensure total dryness at time of sealing.
- Longer or larger overlapping areas require spaced holes for progressive venting. Very large overlapping areas should be avoided as they are an undesirable design for galvanizing and are areas of high risk for crevice corrosion.
- The same principles used for general venting and draining should be used for location of vent holes in overlapping areas, i.e. in corners and diagonally opposite.
- There should be a flush fit-up of the items.
- Putting the hole through both sections can also be helpful.

Overlapping surface venting

Spacings less than 2.5 mm will restrict the flow of pre-treatment fluids and prevent the effective flow of zinc into and out of the crevice, resulting in uncoated areas. For this reason, spacings between overlapped surfaces less than 2.5 mm should be designed with fully sealed welds when the overlap is small, or with vented overlaps as per Table 5 and Figures 31 to 34.

Table 5: Recommendations for minimum actions at areas of overlap

Area of Overlap	Recommended Action
Up to 10,000 mm ²	Fully sealed weld
10,000 to 100,000 mm ²	In diagonally opposite positions, either <ul style="list-style-type: none"> 2 x ≥ Ø12 mm holes at the corners, or 2 x ≥ 25 mm intermittent welds at the corners
100,000 to 250,000 mm ²	Either <ul style="list-style-type: none"> 4 x ≥ Ø12 mm holes at corners, or 4 x ≥ 25 mm intermittent welds at the corners
≥ 250,000 mm ²	In diagonally opposite positions, either <ul style="list-style-type: none"> ≥ Ø20 mm holes at corners and progressively placed at least every 250,000 mm², or ≥ 25 mm intermittent welds at the corners and progressively placed at least every 300 mm from the corners

The hole size for venting and draining must be at least the thickness of the steel. In other words, if the overlapping plate is 15 mm thick, then the minimum holes size is Ø15 mm.



Figure 31: Overlapped surfaces larger than 10,000 mm² require venting.

For intermittent weld designs

The minimum space between the surfaces of the two components shall be at least **2.5mm**.

This ensures:

- The overlapped area is self-venting.
- Avoids pre-treatment solutions being trapped in the gaps during the galvanizing process and seeping out over time.
- Allows all surfaces to be galvanized.

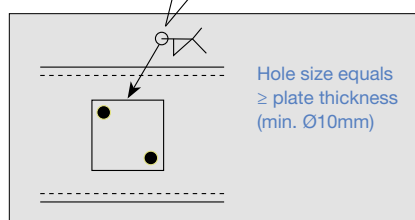
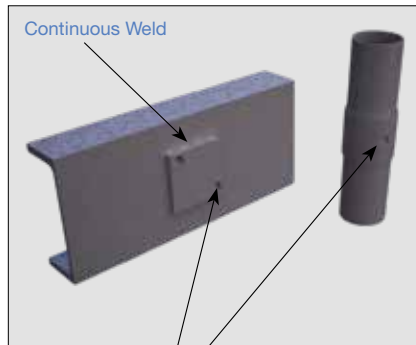


Figure 32: Overlapping Surfaces

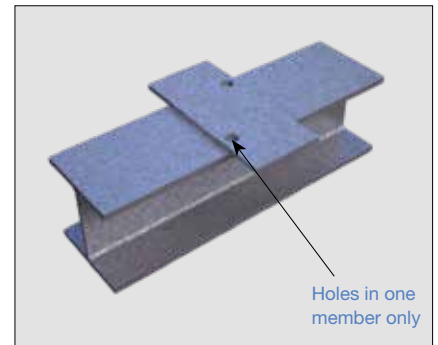


Figure 33: Overlapping Sections

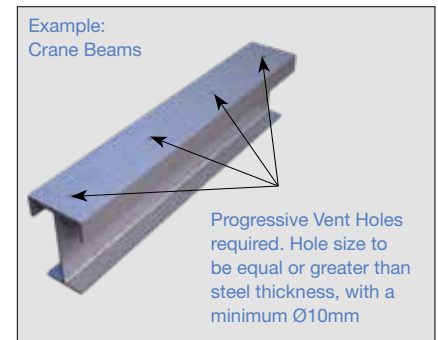


Figure 34: Overlapping Areas



Moving Parts



Table 6: Recommended minimum radial clearance before galvanizing

Shaft or spindle size (mm)	Minimum radial clearance (mm)
< Ø10	1.0
≥ Ø10 to ≤ Ø30	2.0
> Ø30	2.5

Note: Some fettling may be required after galvanizing to enable parts to be free moving.

Where articles require free movement of parts, e.g. drop handles, hinges, shackles, shafts or spindles:

- A radial clearance should be applied to the part to allow for the galvanized coating thickness. Recommended minimum radial clearances are shown in Table 6.
- Parts need to be disassembled and galvanized separately.

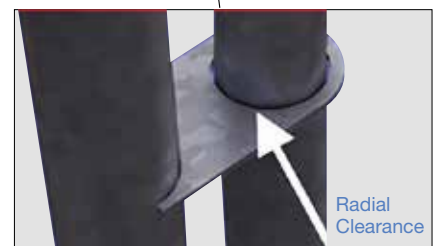
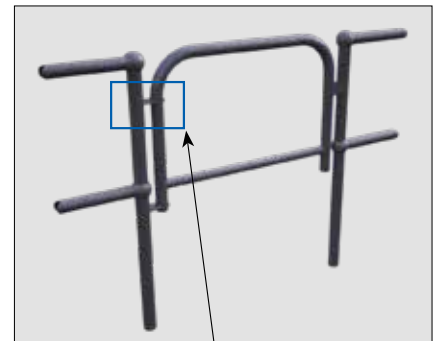


Figure 35: Moving Parts – Swinging Gate

Threaded Items



Due to their small relative size, threaded fasteners, nuts and washers are usually hot dip galvanized via the centrifuge process. Like other moving parts, each part needs to be galvanized separately.

- The HDG process develops a coating of a minimum average thickness of 50µm on threads, as defined in ISO 10684. Hence, it is necessary to form bolt threads to special limits to accommodate the coating.

- There are two different methods of manufacture which take into account the necessary clearances for the HDG coating applied to fasteners.
- The usual method consists of using nuts tapped oversize to tolerance class 6AZ or 6AX after coating, to mate with bolts manufactured with threads to tolerance position g or h before coating. ISO 10684 provides detailed information on tolerances for bolt manufacturers and marking requirements.

The galvanized coating on the thread of the stud or bolt will provide corrosion protection for the internal thread of the nut.

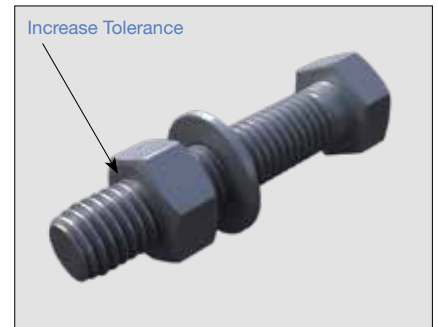
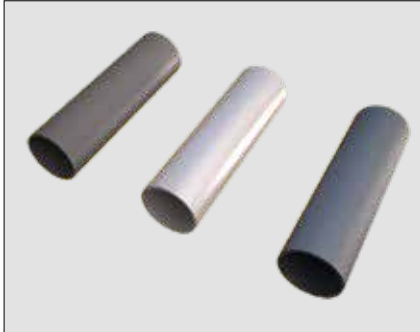


Figure 36: Internal Threads



Appendices



Appendix A – Suitable Materials

- Most ferrous materials are suitable to be hot dip galvanized, including sound stress-free castings.
- Non-ferrous materials such as brass, aluminium and copper are not suited to the hot dip galvanizing process.
- It is not recommended to galvanize stainless steels.
- Most hot rolled or cold formed steels, including structural angles, UB's, UC's, welded beams, channels, welded CHS, RHS & SHS, reinforcement steels and fastener grade steels can be galvanized. In general, the mechanical properties of structural steels are not affected by the galvanizing process.
- High strength steel up to 340HV are also able to be galvanized when acid pickling is not used in the pre-treatment of the steel.
- Steel composition (particularly silicon and phosphorus content) can affect the characteristics of the hot dip galvanized coating.
- Sulphur-containing free-cutting steels (for example S1214) are normally unsuitable for hot dip galvanizing.
- Grey cast iron and malleable cast iron can be galvanized, but special considerations need to be met. For more information, refer to ISO 14713-2.

- Combinations of ferrous materials or surface conditions
- Fabrications containing a combination of castings and steels, or rusted and mill scaled surfaces may be abrasive blast cleaned before galvanizing to provide a more consistent initial surface finish.
- Weld slags must be removed, which can be done via chipping, grinding, or using a pneumatic needle gun.
- Brazed assemblies may be galvanized, but check first with your galvanizer.
- Soft soldered assemblies cannot be galvanized.

Appendix B – Identification & Marking

The type of identification needed for steel articles influences the recommended method of identification.

Permanent identification

For permanent identification, recommended methods are:

- Heavily embossed markings
- Punched markings
- Welded markings

Temporary identification

Before and after galvanizing: the recommended method is the use of heavily embossed metal tags, generally attached to the article via wire.

Prior to galvanizing: recommended methods are water-based paints or marking pens.

Identification methods not acceptable:

- Oil-based paints or marking pens
- Stickers

Oil-based paints or marking pens and adhesive residue from stickers cannot be fully or effectively removed by the normal pre-treatment performed during the galvanizing process and will generally result in ungalvanized areas on the article where the identification was located.



Figure 37: Identification Markings



