DESIGN FOR GALVANIZING

Guidelines emphasising the need for access and drainage of molten zinc

When designing a structure which is to be hot dip galvanized, it must be borne in mind that articles are immersed into and withdrawn from a bath containing molten zinc heated to a temperature of 450ºC. Design and fabrication is required to conform to acceptable standards which apply, regardless of whether a galvanized or a painted coating is to be applied. In the case of galvanizing, some additional requirements which aid access and drainage of molten zinc, will improve the quality of the coating and also reduce costs.

With certain fabrications, holes which are present for other purposes may fulfil the requirements of venting of air and draining of zinc; in other cases it may be necessary to provide extra holes for this purpose.

For complete protection, molten zinc must be able to flow freely over all surfaces of a fabrication. With hollow sections or where there are internal compartments, the galvanizing of the internal surfaces eliminates any danger of hidden corrosion occurring in service.

If there are any doubts or questions, please contact your galvanizer.

It is essential that work is sent to the galvanizer in a suitable condition for galvanizing. Failure to do so may affect the quality of the galvanized coating produced.

IDENTIFICATION MARKINGS

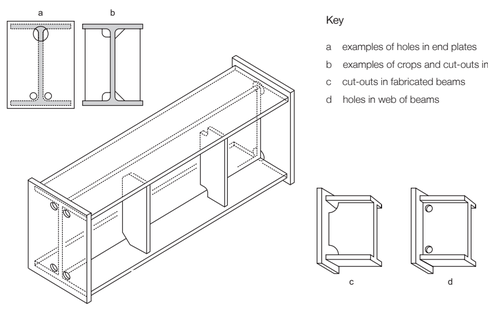
For permanent identification use heavily embossed, punched or welded lettering. For temporary identification use heavily embossed metal tags wired to the work, water soluble paint or the correct marking pen.

Do not use enamel/oil paints, adhesive labels or any other coating that cannot be readily removed by degreasing or pickling.

ACCEPTABLE - Embossed Marking, Welding ID, Light Rust or Millscale

UNACCEPTABLE - Welding Slag, Paint, Grease or Oil, Silcone/Oil Based Weld Anti-Spatter Sprays, Unvented Sealed Hollow Sections, Mould Sand on Castings

Fig 1*

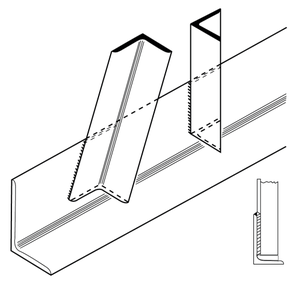


Key

a examples of holes in end plates
b examples of crops and cut-outs in stiffeners
c cut-outs in fabricated beams
d holes in web of beams

External stiffeners, welded gussets and webs on columns and beams and gussets in channel sections should have their corners cropped. The gaps created should be as large as possible without compromising structural strength. If welding is required around the edge created, a radiused corner is desirable, to facilitate continuity of the weld around the cut end to the other side. Circular holes are less effective; if used, they should be as close to corners and edges as practicable. Consultation with the galvanizer, regarding the appropriate vent and drainage hole sizes is recommended.

Fig 5



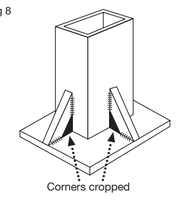
Angle bracings should, if possible, be stopped short of the main boom flange.

STRENGTHENING GUSSETS AND WEBS

Welded strengthening gussets and webs on columns and beams, and strengthening gussets in members fabricated from channel or I-beam sections should have corners cropped or holed (Figures 1 & 8):

- To prevent the entrapment of air in pockets and corners allowing complete access of cleaning solutions and molten zinc to the entire surface of the work.
- To facilitate drainage during withdrawal from degreaser, cleaning solutions, rinse water, flux and molten zinc.

Fig 8



CLEARANCE FOR MOVING PARTS

Drop handles, hinges, shackles, shafts and spindles require a minimum radial clearance, to allow for the thickness of the hot dip galvanized coating.
(see Figure 9) and Table 3.

Fig 9

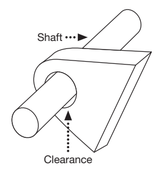
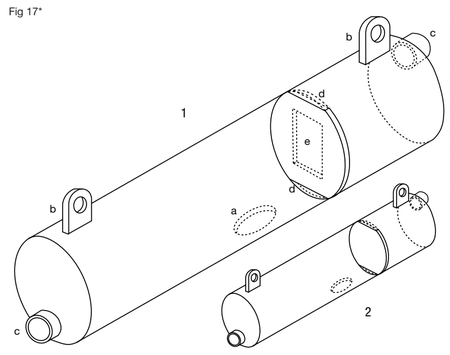


Table 3

Shaft or spindle size	Minimum radial clearance
Up to 30 mm diameter	2.0 mm
Over 30 mm diameter	2.0 - 2.5 mm

Fig 17*



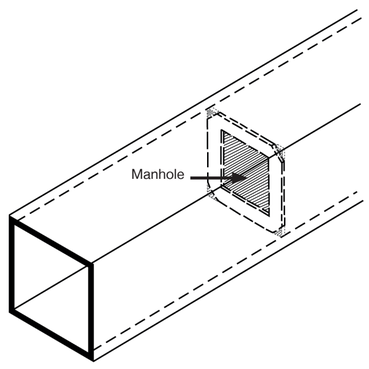
Key

1 Large vessel
2 Small vessel

a Inspection or access hole
b Lifting lugs
c Vents
d Internal baffles (cropped top and bottom)
e Man-way (large vessels)

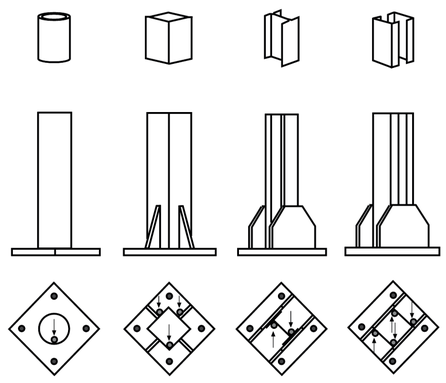
For tanks, vents should be diametrically opposite and at least 50 mm in diameter. Internal baffles should be cropped top and bottom. Lifting lugs are required as indicated. It should be possible to view the baffles through either the vent holes or an inspection hole – the placement of the inspection hole should be discussed with the galvanizer.

Fig 2



Internal diaphragms in large box sections should have cropped corners and a 'manhole'. Internal diaphragms on small box sections should have cropped corners.

Fig 6*



Alternative designs for venting sections fixed to base plates. Vent holes at each end of the fabrication should be diagonally opposed as shown above. The preferred option should be determined in conjunction with the galvanizer.

WELDED PIPE SECTIONS

Sealed sections must never be incorporated in a fabrication. External holes may be positioned as in Figure 10, since quick visual inspection shows that the work is safe to galvanize.

SMALL TUBULAR FABRICATIONS

Small tubular fabrications must be vented, preferably with holes not less than 10 mm diameter.

TUBULAR FABRICATIONS/HOLLOW STRUCTURALS

Drain/vent hole sizes should be preferably 25% of internal diameter or diagonal dimension for sections yielding a maximum cross section area of 180 cm² (Figures 12 and 13). This percentage can be dependent on the shape of the fabrication, therefore consultation with the galvanizer at the design stage is recommended.

Fig 10

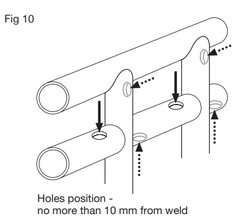


Fig 11*

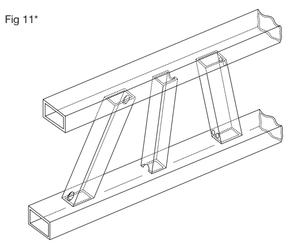


Fig 12

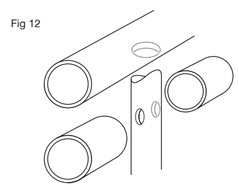


Fig 13

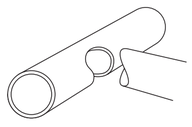
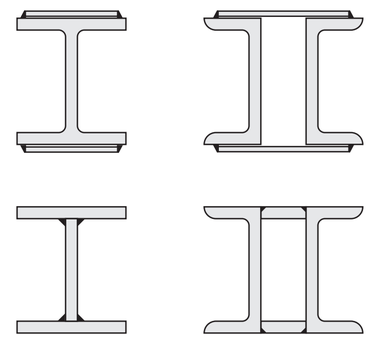


Fig 18*



Welded joints should be continuous if they are not enclosing an otherwise unvented surface. Bolted joints are best made after galvanizing.

DISTORTION

Distortion can be minimised by:

- Use of symmetrical designs.
- Use of sections of a similar thickness.
- Use of hot rolled rather than cold rolled or cold formed sections.
- Where a fabrication incorporates sealed hollow sections, ensure that well positioned vent holes of the appropriate size are provided.
- Use of preformed members with the correct minimum bend radius to minimise stress.
- Use of balanced or staggered welding techniques to minimise stresses.
- When welding work ensure that it is not jigged excessively tightly.
- Large open fabrications, thin-walled trough sections and tanks may require temporary cross-stays to prevent distortion during hot dip galvanizing (Figure 20).

GUIDANCE ON VENT HOLE SIZES FOR HOLLOW SECTIONS OF DIFFERENT SIZES

This guidance relates to sealed hollow sections which do not have venting within the main section of the component.

An indication of the vent hole size required is given in the table opposite, the vent hole size being dependent upon the size of the hollow section to be galvanized. Note that where long hollow sections are to be galvanized additional vent holes may be required so as to aid drainage and to help produce a better surface finish.

The guidance given in the table is provided to allow drainage of zinc in order to achieve the best quality surface finish. Hole sizes smaller than provided in this table may be required for specific designs and applications, e.g. children's playground equipment. However, in all instances hole sizes must satisfy minimum health and safety criteria for galvanizing. It is recommended that you consult your galvanizer for such guidance, as required.

Note 1
The shaded holes or crops indicate the hole or crop in the opposite end of the hollow section.

Note 2
The size of crop given in this table refers to the length of the adjacent side of the crop (not the diagonal length).

Note 3
Table entries that are not applicable are designated by '–'.

Section cross-sectional shape and dimensions (mm)			Number and location of holes or crops at each end of the hollow section										
			1 hole	1 hole	2 holes	2 holes	2 crops at corners	4 holes	4 holes	4 crops at corners	4 holes of 15 mm + 1 central hole	4 holes of 15 mm + 1 central hole	4 crops at corners of 25 mm + 1 central hole
Round	**Square**	**Rectangular**	Diameter of the hole (mm)				Size of Crop (mm)	Diameter of hole (mm)		Size of Crop (mm)	Diameter of central hole (mm)		
15	**15**	**–**	10	10	–	–	–	–	–	–	–	–	–
20	**20**	**30 × 15**	10	10	–	–	–	–	–	–	–	–	–
30	**30**	**40 × 20**	12	12	10	10	–	–	–	–	–	–	–
40	**40**	**50 × 30**	14	14	12	12	10	–	–	–	–	–	–
50	**50**	**60 × 40**	16	16	12	12	13	10	10	–	–	–	–
60	**60**	**80 × 40**	20	20	12	12	15	10	10	12	–	–	–
80	**80**	**100 × 60**	25	20	16	16	20	12	12	15	–	–	–
100	**100**	**120 × 80**	30	25	20	20	25	14	15	20	–	–	–
120	**120**	**160 × 80**	35	30	25	25	30	20	20	25	–	–	–
160	**160**	**200 × 120**	45	40	35	30	40	25	20	30	35	–	–
200	**200**	**260 × 140**	60	50	40	35	50	30	25	35	50	40	–
300	**300**	**350 × 250**	–	–	60	55	75	45	40	55	80	70	75
400	**400**	**450 × 250**	–	–	80	75	100	60	50	75	110	100	110
500	**500**	**600 × 300**	–	–	100	90	125	75	65	90	140	125	135
600	**600**	**700 × 400**	–	–	120	110	150	85	75	110	170	150	165

Table 1* Guidance on vent hole sizes for hollow sections of different sizes

LOCATION OF VENTING AND DRAINAGE HOLES

Fig 3

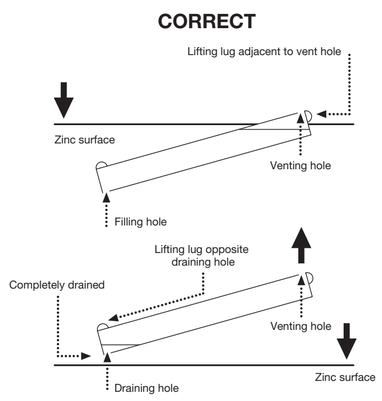
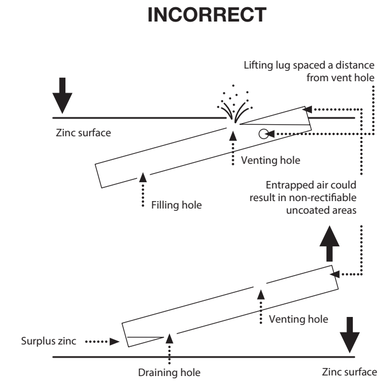


Fig 4



RECOMMENDED MINIMUM EDGE DISTANCE OF VENT AND DRAIN HOLES FOR WELDED BOX SECTIONS

For welded box sections, the use of crops is preferable but, if holes are used, the recommended distance from the edge of the weld given in Table 2 should be applied.

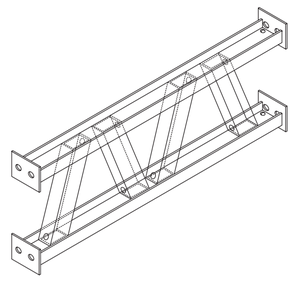
Table 2*

Type/size of weld (a = weld throat thickness)		Edge distance (mm)
Fillet	Groove (HY or HV)	
a ≤ 7 mm	a ≤ 8 mm	10
7 mm < a ≤ 10 mm	8 mm < a ≤ 14 mm	15
10 mm < a ≤ 14 mm	14 mm < a ≤ 20 mm	20

VENTING OF STRUCTURAL MEMBERS WITHIN A FABRICATION

Work should be vented to allow for the escape of air and the free drainage of zinc over the article. The position of the vent holes should generally be diagonally opposite (see Figure 7) and be related to the alignment of the work during immersion into and withdrawal from, the galvanizing bath.

Fig 7*



Orientation during hot dip galvanizing and indicative venting

VENTING OF OVERLAPPING SURFACES

Overlapping surfaces are potentially dangerous as air trapped between surfaces may be converted to superheated steam in the galvanizing bath and can lead to an explosion. For overlapping surfaces which are larger than 100 cm² and sealed by continuous welding, holes should be drilled as indicated in Figures 14, 15 and 16, which illustrate venting for overlapping areas of different sizes.

The number and size of holes required to vent an overlapping area takes account of the area of overlap and guidance is provided in Table 4. Ideally holes should be through both sections to aid the free flow of zinc. An alternative is to use intermittent welds but this may result in pretreatment solutions becoming trapped between the overlapping surfaces resulting in seepage staining during service.

Fig 14*

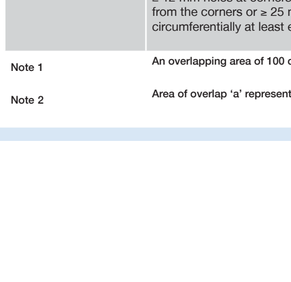


Fig 15*

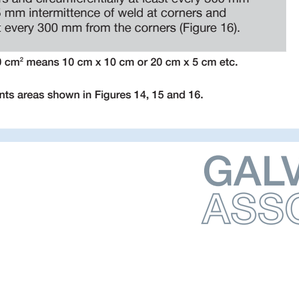


Fig 16

Table 4*

Area of Overlap 'a'	Recommended Action
a ≤ 100 cm²	Circumferential tight weld. The material should be dry for the welding process and overlapping parts should be smooth and assembled without gaps.
100 < a ≤ 1000 cm²	In diagonally opposite corners, either: 2 x ≥ 12 mm holes at corners or 2 x ≥ 25 mm intermittence of weld at corners (Figure 14).
1000 < a ≤ 2500 cm²	Either: 4 x ≥ 12 mm holes at corners or 4 x ≥ 25 mm intermittence of weld at corners (Figure 15).
a > 2500 cm²	In diagonally opposite positions, either: ≥ 12 mm holes at corners and circumferentially at least every 300 mm from the corners or ≥ 25 mm intermittence of weld at corners and circumferentially at least every 300 mm from the corners (Figure 16).
Note 1	**An overlapping area of 100 cm² means 10 cm x 10 cm or 20 cm x 5 cm etc.**
Note 2	**Area of overlap 'a' represents areas shown in Figures 14, 15 and 16.**

ADDITIONAL GUIDANCE FOR DESIGN OF STRUCTURAL STEELWORK FOR HOT DIP GALVANIZING

In circumstances where, due to design restrictions, general design guidance cannot be followed and the introduction of holes or other fabrication features into the 'K' areas of a section (where the web and flange meet) is unavoidable, please consult GA to discuss how best to finalise the design of the fabrication.

Fig 21

Fig 22

Fig 19

Angles or flats used as stays should be as close as possible to the tank wall thickness.

Fig 20

Fig 23

Fig 24

Cope cutting of beams is a common feature in modern steel construction. For optimum results during galvanizing (see figures above), where flame-cut copes have been introduced into a fabrication, the following steps are recommended:

- Use a large radius for the cope - 20 mm minimum if possible.
- After cope cutting, grind off any hardened steel surface layer.
- Provide a smoothly ground cope cut surface avoiding notches, grooves and other surface irregularities.
- Chamfer the edges to the cope cut.

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Excellence **in Galvanizing**

WEDGE

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Further guidance is given in EN ISO 14713-2:2020.

Please note, diagrams are not to scale.