



Advisory Note

Distortion becoming a diminishing event

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There is a perception that distortion of fabricated steel items is a significant problem, however, in reality, distortion occurs in only a very small number of instances. Distortion has become a rare occurrence as bath sizes and handling facilities have improved.

Over recent years the after fabrication galvanizing industry has undergone major upgrades in terms of steel handling capabilities and larger plant capacity which has resulted in a further reduced incidence of distortion occurring when fabricated steel articles are galvanized.

Occurrence

Galvanizing will not generally cause distortion provided that design and fabrication principles are correct. When steel fabrications do distort during galvanizing, the reasons have usually been 'built-in' at an earlier stage. Distortion almost always arises from the relief of stresses as the steel is heated to the galvanizing temperature (usually 445-465°C). Although such stresses may be inherent in the steel and may vary from batch to batch, they are more commonly caused during fabrication. Distortion may also occur if steels of significantly different thicknesses are joined together in a fabrication. Only very rarely is it caused by handling in the galvanizing plant.

Basic design points and other means of minimising distortion are outlined in this leaflet. Symmetrical section (I - beams, tubes), have less inherent tendency to distort than asymmetrically ones (channels). Similarly, cylindrical vessels are less liable to distort than rectangular or elliptical ones. Other things being equal, the lighter the gauge of steel, the greater the risk of distortion.

Designer, fabricator and galvanizer should pool their knowledge at an early stage to get best results.

Inherent Stresses In Steel

Steel invariably contains internal stresses, hot dip galvanizing can release or vary the amount of stress, making distortion possible.

Fabrication Stresses

Minimising introduction of stresses during welding.

Welding results in extreme differences in temperatures within small areas of an assembly and hence in significant residual stresses.

In general it is recommended that:

- Components of an assembly should be preformed accurately so that they need not be forced, sprung or restrained during welding.

- Thick sections should be continuously welded, thin sections and sheet fabrications may benefit from intermittent welding, depending on whether or not heat is conducted rapidly away from the weld, although more stress may arise at the starting point of the weld.
- As far as possible, welded assemblies should be aligned so that the stresses are balanced rather than all pulling in the same direction.

Other design features to avoid or minimise distortion

Steel sections should vary as little as possible. Thick and thin sections absorb and lose heat at different rates and so can expand and contract unevenly. Large unsupported flat sheets may tend to buckle so stiffeners should be included in the design. Frames around the flat panel, whether of solid steel or open material such as welded mesh should be galvanized separately, as the frame would offer a constraint and so tend to cause buckling rather than reduce it.

Where there is an inherent tendency to distort e.g. in asymmetrically shaped fabrications (including fabricated girders or lattice beams with top or bottom chords of different sections), the effect can be minimised or possibly eliminated if the fabrications is of such a size and design that it can be rapidly immersed in a single dip. Whether or not this can be done will depend on both the size of the sections in relationship to the galvanizer's dipping facilities, and also on the extent to which hollow sections are involved. The galvanizer should be consulted to decide on the maximum advisable lengths. There is little or no distortion in standard symmetrical components whether they are single or double- end dipped - however if larger fabrications need to be double- end dipped, the significant thermal gradient created by this procedure may give rise to distortion.

Where some bowing, twisting or bending has occurred it may be possible to straighten the object after the galvanizing process.

Stress Relief

Fabrication stresses can sometimes be eliminated by stress relieving before galvanizing.

Early consultation between galvanizer, fabricator and designer is the key to success in avoiding distortion, through the incorporation of good design features.

Basic design considerations are shown on the reverse side of this leaflet.

Plate Products

Plate material can present a distortion risk, especially plate under 10 mm in thickness.

To minimise distortion problems, the following rules should be observed:

- Where possible, galvanize the plate separately from any frame or supporting steel work and assemble after galvanizing
- Recommend that uniform processing of the plate be specified during fabrication; i.e. Shear the plate where possible and minimise oxy cutting of long edges
- Putting holes in the centre of floor plates will assist in minimising buckling as the plate expands into the hole during heating
- Specify air cooling where possible
- Avoid double dipping where possible

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DESIGN FOR GALVANIZING

Certain rules must be followed when designing components for galvanizing, but the rules are readily applied and in many cases they are simply those which are good practice to ensure maximum corrosion protection.

Adoption of the following design practices will ensure the safety of galvanizing personnel, ease the galvanizer's task, and produce optimum quality galvanizing design details check with your galvanizer or Galvanizers Association of Australia.

Size and shape

Almost any component can be galvanised by designing and building in modules to suit available galvanizing facilities, but it is wise to check work dimensions with your galvanizer at an early design stage.

Safety

Vessels and hollow sections, including those in small diameter tubular fabrications, must be vented to atmosphere for the safety of galvanizing personnel and to prevent possible damage to the article. At galvanizing temperatures moisture trapped in closed sections is converted rapidly to superheated steam, generating explosive forces unless vented.

galvanizers

ASSOCIATION OF GALVANIZERS
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Galvanizers Association of Australia comprises the leading galvanizing companies in Australia.

GAA provides technical assistance to users and publishes the 72 page manual 'Hot Dip Galvanizing', a practical reference on hot dip galvanizing and galvanizing coatings, including sections on metallurgical aspects, properties and performance. Chapters cover galvanizing reinforcement for concrete, design, bolting, welding and painting of galvanizing steel. A directory of galvanizing companies is also provided. GAA distributes a range of free technical literature on hot dip galvanizing. We invite you to add your name to the GAA mailing list by contacting The Galvanizers Association of Australia, 124 Exhibition Street, Melbourne Victoria 3000. Ph: (03) 9654 1266 Fax: (03) 9654 1136 Email: gao@gaa.com.au



Members of International Zinc Association

Welded pipe sections
Closed sections must never be incorporated. Sections should be interconnected using open, mitred joints as illustrated at 'A', or interconnected holes should be put in before fabrication as in 'B'.

Alternatively external holes may be positioned as in 'C', a method which is often preferred by the galvanizer, as it allows close inspection to ensure that the work is safe to galvanize.

Pipe ends must be left open, or provided with removable plugs.

Small tubular fabrications must be vented, with holes not less than 6 mm diameter.

Tubular fabrications and hollow structural
Closed sections must never be incorporated. Provide vent holes at least 25% of internal diameter or diagonal dimension at locations agreed with the galvanizer. For 100 x 100 SHS use 36mm dia hole; note that multiple vent/drain holes can be used to achieve same result.

Alternatively 'Y' notches can be cut in ends of members before welding.

Open mitred joints

Holes should be located with the depth on both sides of diagonal, opposite to each other.

Holes 10 mm or larger

Holes 6 mm or larger

Holes 10 mm or larger

Unwanted vent holes may be closed by the use of epoxy filler after galvanizing and filling of flush with surrounding surfaces.

Overlapping surfaces
Avoid narrow gaps between plates, overlapping surfaces, and back-to-back angles and channels.

When small overlaps are unavoidable, seal edges by welding.

When left unsealed, small overlapping edges may trap pickling liquid which will escape to discolour or damage the galvanized coating.

Larger overlapping surfaces
If contacting surfaces cannot be avoided, a hole 6 mm in diameter for every 100 cm² of overlap area should be placed in one of the members, and the perimeter of the contacting area should be continuously welded. The vent hole in one member will ensure the safety of galvanizing personnel and prevent damage to the article.

A Satisfactory

B Satisfactory

C Unsatisfactory

When both internal and external surfaces are to be galvanised at least one filling and draining hole must be provided, with a vent diagonally opposite to allow the exit of air during immersion. Holes should be at least 50 mm diameter for each 0.5 cubic metres. Manholes should finish flush inside to prevent trapping excess zinc.

When vessels and air receivers etc are not to be galvanised inside, 'spoked' tubes must be fitted after discussion with the galvanizer, to allow air to exit above the level of molten zinc in the galvanizing bath.

Internal baffles cropped top and bottom to allow air to exit and prevent trapping of air. Flange should finish flush inside.

Filling hole at least 50 mm diameter for each 0.5 cubic metres.

Vent pipes connect atmosphere.

Vent diagonally opposite filling hole.

When vessels and air receivers etc are not to be galvanised inside, 'spoked' tubes must be fitted after discussion with the galvanizer, to allow air to exit above the level of molten zinc in the galvanizing bath.

Cropped internal baffles.

Vent hole at least 50 mm for each 0.5 cubic metres.

Internal baffles cropped top and bottom to allow air to exit and prevent trapping of air. Flange should finish flush inside.

Strengthening gussets and webs
Welded strengthening gussets and webs on columns and beams, and strengthening gussets in members fabricated from channel sections should have corners cropped or holed.

1 To prevent the entrapment of air in pockets and corners allowing complete access of pickle acids and molten zinc to the entire surface.

2 To facilitate drainage during withdrawal from acid and rinse tanks, and from the galvanizing bath.

End plates
Provide holes at least 13 mm diameter in end plates on rolled steel shapes, to allow access during withdrawal.

13 mm holes in end plates to corners as a practice.

Cropped corners
Members should be provided as shown.

Distortion
Distortion can be prevented or minimised by:

- 1 Use of symmetrical designs
- 2 Use of relatively uniform sections
- 3 Use of accurately performed members to avoid locked-in stresses
- 4 Use of balanced or staggered welding techniques to avoid locked-in stresses
- 5 Large open fabrications and tanks may require temporary cross stays to prevent distortion during galvanizing

Materials suitable for galvanizing
All ferrous materials are suitable, including stainless steel parts, and sound stress-free castings. Braced assemblies may be galvanised, but check first with your galvanizer. Soft soldered assemblies cannot be galvanised.

Combinations of ferrous surfaces
Fabrications containing a combination of castings and other steels, and rusted or mill scaled surfaces must be abrasive blast cleaned before galvanizing.

Weld slugs
Must be removed by chipping, grinding, abrasive blast cleaning, flame cleaning, or using pneumatic needle gun.

Provision for handling
Work not suitable for handling with chains, brackets, hooks or lugs must be provided with significantly large suspension holes or fittings. If in doubt check with your galvanizer.

Clearance for moving parts
Drop handles, hinges, shackles, shafts, and spindles require provision of minimum radial clearances as detailed in the table below, to allow for the thickness of the galvanized coating.

Shaft or spindle size	Minimum radial clearance
Up to 10 mm diameter	1 mm
Up to 30 mm diameter	2 mm
Over 30 mm diameter	2.0 to 2.5 mm

Internal threads and nuts must be tapped
Internal threads and nuts must be tapped after galvanizing to accommodate the thickness of the galvanized coating on the stud or bolt.

Australian Standard	Allowance, mm
Up to M22	0.40 mm
M24	0.45 mm
M27	0.50 mm
M30	0.55 mm
M36	0.60 mm
M39-48	0.80 mm
M48-64	1.0 mm

Identification markings
For permanent identification use heavily embossed, punched or welded lettering. For temporary identification use heavily embossed metal tags wired to the work.

Do not use paints.