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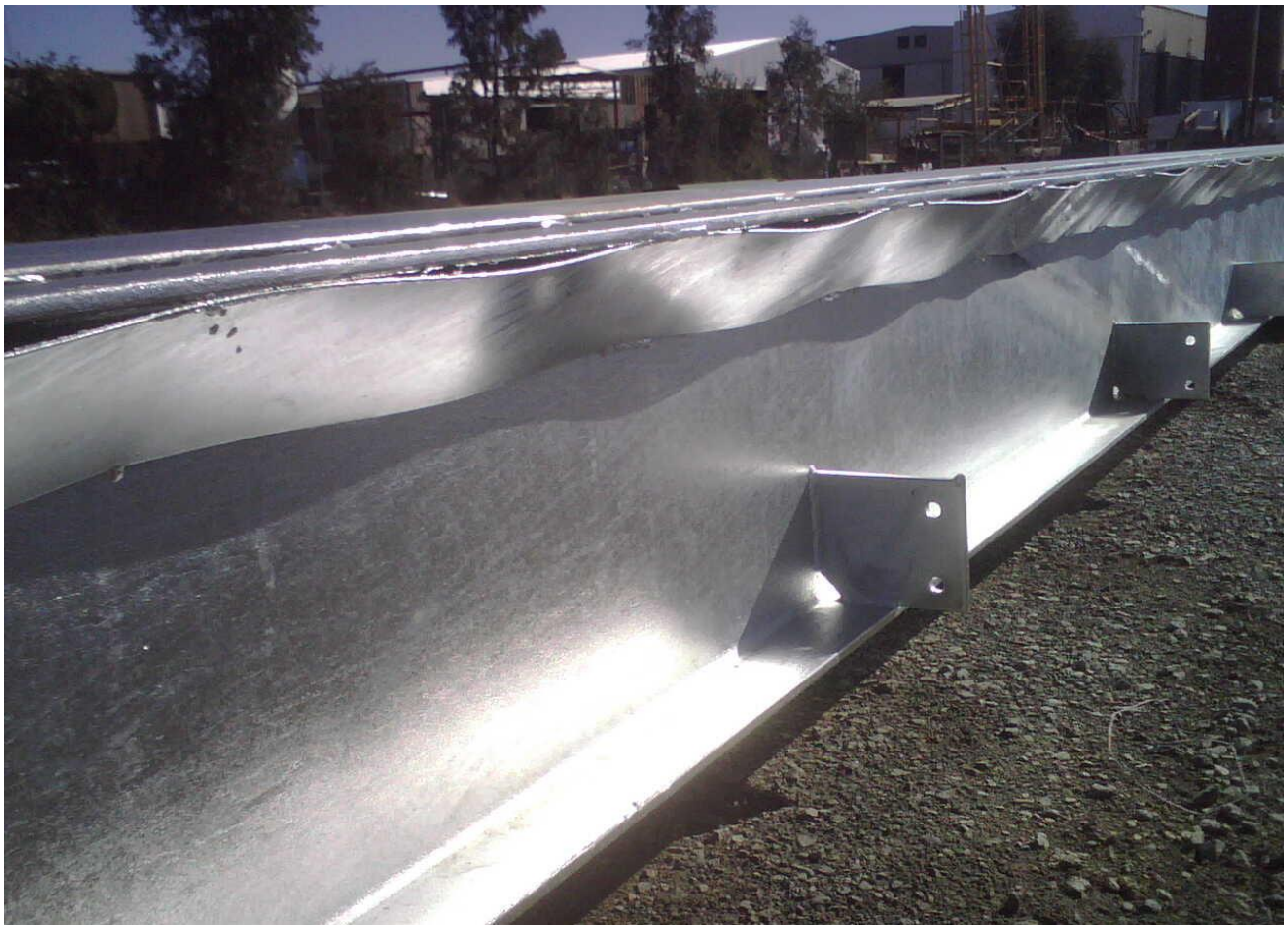

ADVISORY NOTE #13

DISTORTION OF HOT DIP GALVANIZED ARTICLES

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INTRODUCTION

There is a perception that distortion of fabricated steel items is a significant problem, however, distortion occurs in only a very small number of instances and has become a rare occurrence as bath sizes and handling facilities have improved. The reduction in the issues surrounding distortion however, do not mean that design and frabrication practices that reduce the likeihood of distortion occuring should not be implemented wherever possible.

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 dipped into the molten 450°C of the galvanizing bath. 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 document. Symmetrical sections (I-beams, tubes), have less inherent tendency to distort than asymmetrical sections (channels). Similarly, cylindrical vessels are less liable to distort than rectangular or elliptical ones. As a genereal rule the lighter the gauge of steel, the greater the risk of distortion. One possible solution that may reduce the likelihood of distortion occuring in structures that consist of lighter section is the inclusion of bracing or stiffening plates in areas of particular concern.

Commmunication between the designer, fabricator and galvanizer at an early stage is the best option to ensuring the customer recieves the best results.

INHERENT STRESSES IN STEEL

Steel being galvanized progresses through a temperature cycle upon immersion into and withdrawal from the galvanizing bath. Because parts are immersed at an angle, uneven heating occurs, creating a temperature profile along the part being galvanized. This temperature profile allows the steel's internal stresses to be relieved at different times in the immersion cycle. These stresses may cause changes in shape and/or alignment (distortion and warping).

Figure 1: Variations in steel sections can lead to distortion of the differing attached sections

FABRICATION STRESSES

Minimising the introduction of stresses during welding.

Welding two pieces of steel together can result in extreme differences in temperatures within small areas of an assembly and hence significant residual stresses.

In general it is recommended that:

- Components of an assembly be pre-formed 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.
- 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 tend to cause buckling rather

than reduce it. The other recommended option is to weld every second mesh stand to the frame, rather than all of them. This allows some movement in the frame during the galvanizing process.

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 eliminated if the fabrication 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.

Figure 2: Distortion of a long, thin unbraced plate

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.

AS/NZS 2312.2 – Appendix A is recommended as a further reference for more information regarding good design practice for articles to be hot dip galvanizing .

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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
- Provide suitable hanging points that balanced the article, limiting unevenly distributed forces that occur when the article is hung and dipped.

Figure 3: Distortion of galvanized trailer deck with insufficent bracing

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GENERAL RULES TO FOLLOW

The following list summarises the general design and fabrication rules that are recommended if there is a likelihood of distortion of articles during the galvanizing process:

- Specify air cooling where possible
- Avoid double dipping where possible
- Where possible, use symmetrically rolled sections in preference to angle or channel frames. I-beams are preferred to angles or channels.
- Use parts in an assembly of equal or near equal thickness, especially at joints.
- Use temporary bracing or reinforcing on thin-walled and asymmetrical designs.
- Bend members to the largest acceptable radii to minimize local stress concentration.
- Accurately pre-form members of an assembly so it is not necessary to force, spring, or bend them into position during joining. Continuously weld joints using balanced welding techniques to reduce uneven thermal stresses. Pinholes from welding are very dangerous in items to be galvanized and must be avoided. Staggered welding techniques to produce a structural weld are acceptable. For staggered welding of 4 mm or lighter material, weld centers should be closer than 100 mm.
- Avoid designs that require progressive-dip galvanizing. It is preferable to build assemblies and subassemblies in suitable modules so they can be immersed quickly and galvanized in a single dip. In this way, the entire fabrication can expand and contract uniformly. Where double dipping is required, consult your galvanizer.

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