- Allowing for linear expansion in the design so that any distortion is elastic and is not constrained by any cross bracing.

Distortion as a result of double end dipping is rarely seen in simple pipes and poles due to their symmetry and simple design.

Long thin objects

Generally, long thin poles and pipes will not necessarily distort due to their symmetrical design. Should they be lifted at both ends, however, they may take on a characteristically bowed shape following the hot dip galvanizing process. Distortion is aggravated if fill and drain holes are insufficient in size, allowing the object to retain molten zinc when being lifted from the galvanizing bath. Bowing of this nature becomes permanent when the steel cools.

The following three methods are suggested to avoid or reduce distortion arising from the above:

- Lifting lugs or holes should be provided at quarter points.
- Vent and drain holes should be located and sized to maximise the rate of drainage and minimise the retention of molten zinc inside the section.
- The vent holes are to be located on the same side as the lifting lugs and the drain holes on the opposite side.

Designing to avoid distortion

During the design stages of large and complicated structures it is important to review the question of distortion with the hot dip galvanizer and/or the Association. In this way controls are introduced at the design stage taking into account the fabricating process and ensuring that the components are suitable for hot dip galvanizing to avoid potential distortion.

Reference: Association's Information Sheet No 10 "Avoid Distortion".

The performance of Pandrol rail fasteners in a marine environment on the Natal South Coast

Two sites were selected on the Natal South Coast for this study, viz, Park Rynie some 65kms south of Durban and Port Shepstone, 115kms south of Durban. Both areas were selected on the basis of their proximity to the sea being within 100 to 200 metres of the high water tide level. Surrounding corrosive conditions were observed by the review of other steel components in the area.

Park Rynie

- The Park Rynie site *(figure 1)*, visited on 19 May 2004, is located approximately 65kms south of Durban. Zinc coating thicknesses measured as follows: minimum 83µm, mean 121µm and maximum 150µm.
- Coating thickness measurements were taken on a Pandrol rail fastener and cast iron shoulder, both components having being hot dip galvanized. The hot dip galvanized coating on the Pandrol rail fastener measures 143µm *(figure 2)*.
- Coating thickness of the hot dip galvanized cast-iron shoulder measured 134µm *(figure 3)*. It is estimated that these components have been in service for between 18 to 20 years. By providing the same degree of corrosion protection to the shoulder clip assembly, a balanced design is achieved without the potential for a galvanic couple.
- A painted steel mast at the Park Rynie rail crossing illustrates the severity of the corrosive environment experienced at this particular site *(figure 4)*. It is believed, subject to confirmation, that this mast was coated with an epoxy tar.

Port Shepstone

- The sea is approximately 200 metres to the left of the Port Shepstone site and the town some 6kms further south *(figure 5)*. Zinc coating thicknesses measured as follows: 136µm minimum, 154µm mean and 197µm maximum.
- The seaside (using an ungalvanized cast iron) shoulder had corroded away exposing the hot dip galvanized Pandrol *(figure 6)*. The holding capacity of this particular fastener has become totally ineffective. Note the condition of the "land (lee) side" of the rail, where the system is intact and operative.
- *Figure 7* shows an example of a missing fastener, where the "ungalvanized" cast-iron shoulder is presumed to have

Figure 1.

Figure 2.

Figure 3.

Figure 4.

corroded away, allowing release and removal of the hot dip galvanized Pandrol fastener. No trace of the Pandrol rail fastener was found.

- *Figure 8* is a general view across the rail track illustrating the location of the site relative to the sea and the resultant marine environment. Note the severe corrosion of the steel fence post in the foreground.
- *Figure 9* indicates the condition of an un-galvanized rail fastener, which is obviously a replacement as it has been installed in the reverse direction to all the other hot dip galvanized fasteners. Note the severe corrosion of the un-galvanized cast-in shoulder and the "pitting type" corrosion that has developed on the un-galvanized Pandrol rail fastener.

From our observations it was clearly established that the side of the rail, together with the fasteners that face the sea were affected to a greater extent than those on the lea side of the track. It can be concluded that the rail provides a degree of "shielding" from the sea spray. This is a subjective observation as it is clear that the severe corrosive environment is attacking both sides of the rail.

The majority of Pandrol rail fasteners were hot dip galvanized, but one or two un-galvanized rail fasteners were found and assumed to be replacement items. In some positions the un-galvanized cast-in shoulder had corroded away and was no longer operative. In four instances the Pandrol rail fastener together with its cast-iron (un-galvanized) shoulder had completely disappeared. This is attributed to the fact that these shoulders were initially installed un-galvanized.

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Figure 5.

In general, all the hot dip galvanized Pandrol fasteners were in very good condition while the occasional un-galvanized Pandrol fastener and many of the un-galvanized cast-iron shoulders were exhibiting severe and advanced state of corrosion.

It could not be determined exactly how long these components have been in service other than the date embossed on the concrete sleeper, which is June 1971. The web of the rail was likewise exhibiting corrosion with the sea side face corroded to a far greater extent than the lee side.

Both the Pandrol rail fastener and the cast iron shoulders were hot dip galvanized, measuring a minium of 87µm, a mean of 108µm and a maximum of 134µm. Minimum deterioration, due to corrosion, was found on these components.

An example of the aggressively corrosive environment along the South East Coast

Figures 10 and 11 are an indication of the corrosive conditions that can be determined from the state of mast 108/14 together with its base. These "ungalvanized" components would appear to have been coated with an epoxy tar or a bitumastic compound. Where the protective coating had been penetrated, corrosion of the steel is at an advanced state.

Figure 6.

Figure 7.

Figure 8:

Figure 9.

Figures 10.

Figures 11.