

## Preface

This document is intended to inform readers about potential surface conditions resulting from batch hot dip galvanizing through the provision of visual and written guidance. AS/NZS 4680 provides guidance in the area of allowable surface conditions after galvanizing, however identification of a non-conforming surface condition of a galvanized article will depend on the stated end use of the product and the extent and nature of the damage to the coating. This document is not intended to replace guidance provided by an expert, such as a galvanizer or accredited hot dip galvanizing inspector, who may be consulted when issues with the surface condition arise.

## Description

Flaking is the separation of the entire zinc coating, including the iron zinc alloy layers from the underlying steel. It is also known as delamination or chipping and should not be confused with peeling (see *TN Peeling*), where only the top pure zinc layer separates from the underlying zinc alloy layers.

## Cause

Flaking is always due to the silicon and phosphorus content in the steel:

- Steels of category C and D in Table 9.1 of AS/NZS 2312.2 are most susceptible (silicon contents between 0.04% and 0.14% or greater than 0.25%).
- Steels with phosphorous content greater than 0.025% can experience flaking after galvanizing, even when the silicon levels are satisfactory
- The steel composition causes the majority of the coating to be a thick and brittle zinc iron alloy layer, which isn't strongly bonded to the steel surface.
- Flaking usually occurs in thicker than normal galvanized coatings (300 µm or more), especially when these coatings receive impact forces during handling (see *TN Handling Damage*).

## Prevention

Flaking can be prevented by:

- Informing the galvanizer of the steel composition so preventative measures can be taken
- Minimising the time articles are immersed in the molten zinc by providing adequate venting and draining
- Cooling thin steels as quickly as possible after galvanizing
- Air cooling thicker steels to avoid thermal shock

## Effect

Steels with very thick coatings can be more easily damaged with flakes coming off after the steel has cooled or as a result of impact, as seen in Figures 1-5. Flaking as a result of impact typically occurs near the edges and creates bare spots in the protective zinc coating (see *TN Bare Spots*), which should be repaired to ensure ongoing corrosion protection.

### Acceptability

The acceptability of flaking when galvanizing to AS/NZS 4680 depends on the resulting condition of the surface and stated end use of the article:

- Flaking resulting in bare spots larger than 40cm<sup>2</sup> are cause for rejection, as per Clause 8.1.
- If the combined area of all bare spots from flaking on an article is larger than 0.5% of the total surface area or 250cm<sup>2</sup> (whichever is the lesser) it is cause for rejection, as per Clause 8.1.
- Any areas smaller than listed above can be repaired according to the requirements of Clause 8.2 as long as the stated end use isn't affected.
- The galvanized coating must be sufficiently adherent to withstand normal handling without flaking, as per Clause 10.

### Responsibility

Flaking can be caused by:

- The steel supplier, when steel has been supplied with a chemical composition in the susceptible range
- The designer, when vent and drain holes are too small, requiring slower immersion and withdrawal from the bath
- The galvanizer, when thicker steels have been quenched instead of air cooled when the steel is known to be susceptible
- The customer, when the flaking is a result of handling damage (see *TN Handling Damage*)

### Remedy

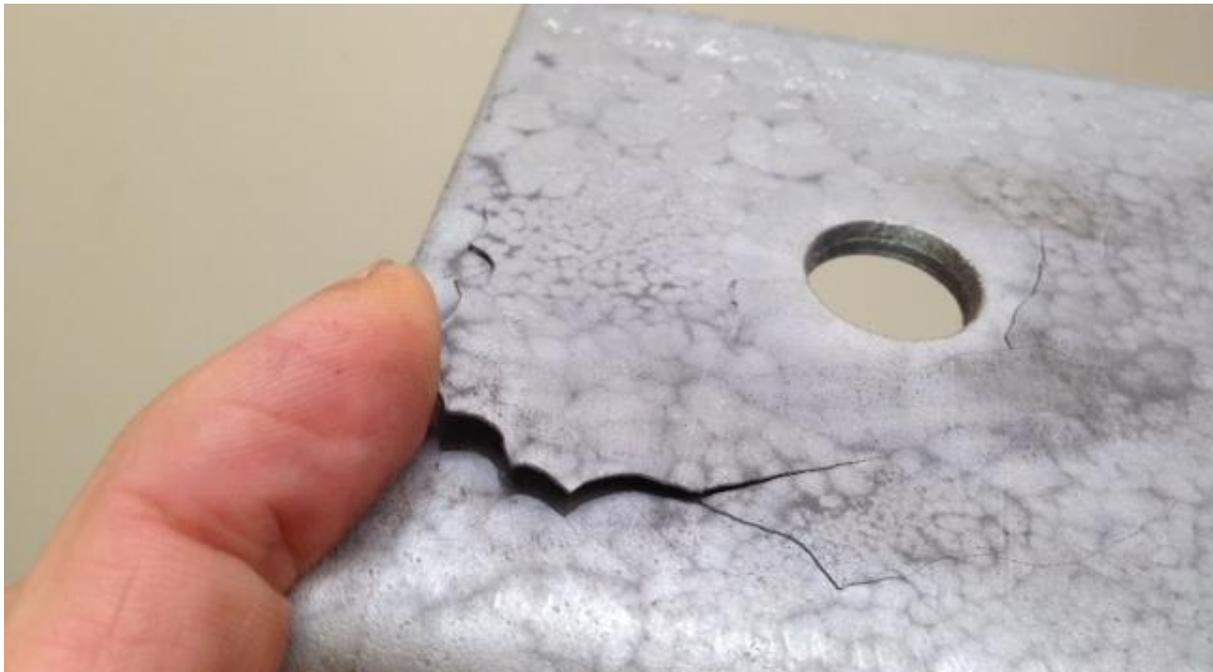
The remedy for flaking depends on the state of the article, with:

- Small bare spots being repaired using a method from Clause 8.2 of AS/NZS 4680 when the end use isn't affected
- Rejected articles can be stripped of the galvanized coating and regalvanized, with the part potentially being air cooled instead of quenched as a preventative measure for thick steels, however there is a chance flaking will occur again. If the issue is suspected to be unavoidable due to steel chemistry, the remedy should be discussed between the customer and galvanizer
- Flaking occurring as a result of fabrication after galvanizing is not the galvanizers responsibility as per Clause 10 of AS/NZS 4680, and the remedy should be discussed with the galvanizer
- When flaking is a result of handling damage, the remedy should be discussed with the galvanizer

### Examples



**Figure 1:** The galvanized coating is flaking off on multiple places of the article. Depending on the size of the bare spots and end use it may need to be regalvanized.



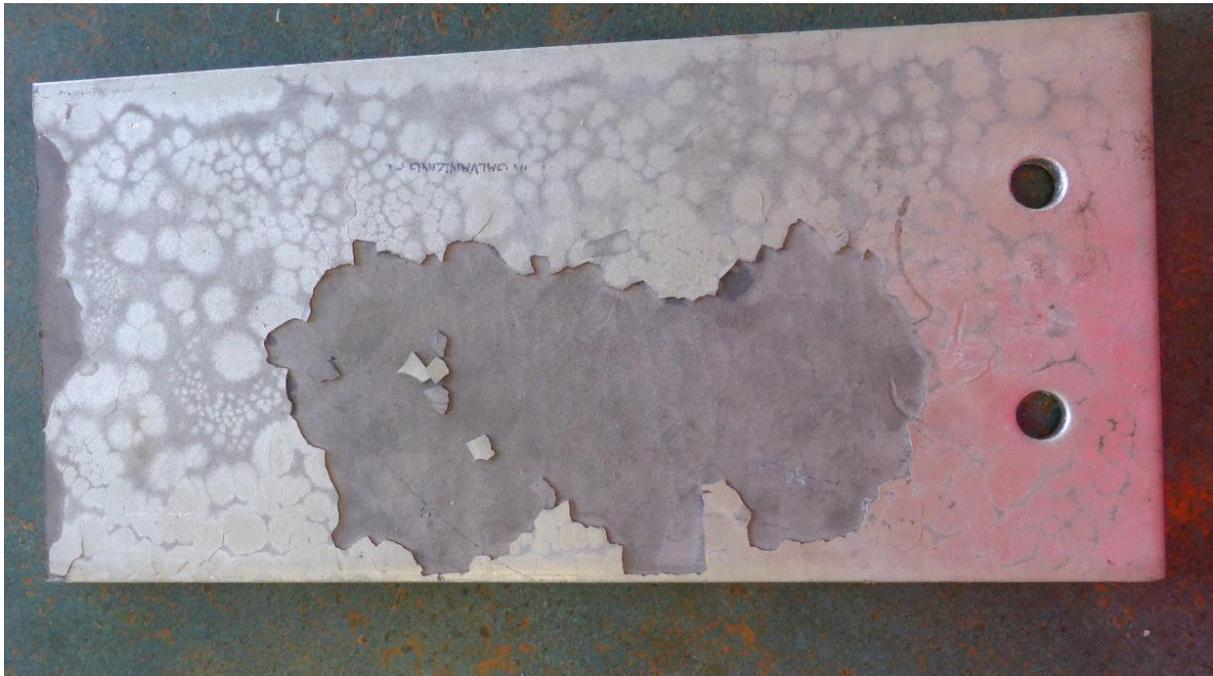
**Figure 2:** The coating is cracking and flaking from contact with a finger and may not be sufficiently adherent to withstand normal handling.



**Figure 3:** The zinc coating is flaking off a fabricated pipe due to the steel chemistry. The mottled grey appearance is indicative of a silicon content between 0.04% and 0.14% (see *TN Mottled Appearance*).



**Figure 4:** The galvanized coating is flaking off thin steel sheets. Thin steels should be cooled as quickly as possible after galvanizing in an attempt to prevent flaking



**Figure 5:** Zinc coating flaking off a steel plate. Thicker steels should be air cooled if possible to avoid thermal shock.



**Figure 6:** Handling damage has caused flaking near the edge of the galvanized article.



**Figure 7:** Impact during handling has caused flaking of the thick, brittle galvanized coating.

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