

Galvanized Steel

TECHNICAL BULLETIN #3

Transit Abrasion on Galvanized Steel Sheet

3.0 Introduction.

Galvanized sheet surfaces sometimes exhibit a surface imperfection that appears as permanent black spots, marks, lines, or patches. This defect has many names, including transit abrasion, friction oxidation, wear oxidation, and chafing; all being terms for a form of erosion-corrosion known as fretting. It is a phenomenon that is more commonly seen on metal surfaces in mechanical assemblies (e.g., bolted, riveted, keyed, or pinned joints) and electrical contacts, but can occur on Galvanized sheet surfaces under certain conditions. While superficial, black fretting marks on Galvanized sheet are almost impossible to remove, and are not the direct result of bulk water damage – which can also cause black (along with white) stains in its most severe form. When fretting occurs on Galvanized sheet surfaces, liquid water is not necessary for its creation, although fretting can occur in the same areas of sheets that are additionally damaged by storage stain from entrapped moisture.

3.1 Mechanism of Fretting Corrosion

Fretting corrosion refers to corrosion on the contact surfaces. This damage occurs under load and in the presence of repeated relative surface motion, as often induced by vibration. The requirements for fretting corrosion are:

- The interface must be under load, vibration, or repeated relative motion must occur
- The load and relative motion must be sufficient to produce deformation on the surface
- Displacements or projections on the surface present a location for fretting

The reason fretting damage can be a severe problem is that it so often happens at the interface of two highly loaded surfaces that are not designed to move against each other. In the case of machinery, it can unknowingly and prematurely wear out parts, and also induce cracks that can become fatigue failures. In electrical equipment it can increase resistance and cause intermittent connections or unexpected circuit failures.

3.2 Fretting Corrosion on Galvanized Sheet

For many years fretting problems have been observed on Galvanized steel in both coil form and bundles of cut length sheets. The defect is never seen at the production line and when found is almost always at customer facilities. It tends to be more prevalent on coil form and on material thicker than 0.030 inches. Without fail, it is also characterized by a lower intensity mirror image on the reverse side of the sheet.

Given that relative motion between surfaces is a requirement for fretting to occur, where do these marks on galvanized come from, and why are they black and impossible to remove short of abrading them off? The relative motion comes from vibrations that occur during shipment of the product. While this type of damage can occur on truck shipments, it is rare, probably because truck transport tends to involve shorter distances (fewer vibration cycles), and perhaps less vibration. How material is supported on trucks (bearing points), and road conditions can have an effect, however, on the propensity for transit abrasion. Transport by train and ship/barge is typically of a longer duration, therefore any vibrations causing low amplitude relative surface motion have much more time to do damage to the surface, and the nature of the movement over steel rails and through water may play more of a part in generating. Also, the high power diesel engines used to propel trains and ships may be a factor in contributing to the generation of these vibrations.

The second factor that contributes to transit abrasion is load on the surfaces. The black marks are rarely over the entire surface area of a sheet, but are concentrated in specific regions, that have been noted in some cases to be the point(s) that bear the weight of the entire coil or bundle, and perhaps the additional load of product stacked on top. These bearing points are where the most pressure would result on any surface areas, and is where fretting would begin if relative motion between surfaces does occur.

The reason the marks on galvanize are black is believed to come from the nature of the extremely small zinc oxide particles (wear debris) that are the likely result of small vibration. Zinc oxide that is formed from corrosion of zinc in the atmosphere, or manufactured intentionally for industrial use, is a white powder. Black transit abrasion marks on Galvanized surfaces have been shown to be zinc combined with a higher percentage of oxygen than is the case with the metallic zinc on the rest of the surface, indicating a different form of zinc oxide. It is theorized that this oxide is black, either because of different optical properties than zinc oxide that appears white, or the manner in which the very fine oxide particles are bonded to the surface of the underlying zinc.

3.3 Minimizing Fretting Corrosion on Galvanized Sheet

There are a host of preventive measures that can be taken to minimize fretting corrosion. An action that is very effective is redesigning support saddles to reduce concentrated point loading on the bottom of coils. By distributing the weight of the coil over the entire area of the saddle(s), there is less pressure at any one point, resulting in less transit damage given that vibration will always be present. A slightly less effective way of accomplishing the same result is to reduce the coil size, but this is perhaps not a desirable option for all situations. With either of these actions, care should be taken to avoid stacking coils during transit, as material on the bottom could become overloaded, even with well-designed saddles under them. Another option to reduce fretting is to oil the sheet, thereby reducing friction. Oiling has been found not to be effective in all circumstances and has other drawbacks, such as telescoping of coil walls; oil oozing from the walls; and being unacceptable to the customer. An obvious cure would be to eliminate the small vibration of coiled or stacked galvanize sheet. Accomplishing this is very unlikely given the nature of long distance shipping methods.

3.4 Sheet with Fretting Marks – Suitability for Use

Fretting marks on Galvanized sheet are surface oxide phenomena that can be a major aesthetic issue, but there is no evidence they have a negative effect on corrosion resistance. In fact, most specifications state that dark spots resulting from friction during shipping generally only impair the appearance.

Any technical information or advice contained in this bulletin is provided without charge as a service to the industry. The use of this information or advice may produce unexpected results, and any persons intending to make use of this information are urged to carry out tests of their own to satisfy themselves they are using the correct materials, approach and techniques. Correctly following the information and advice should produce a satisfactory result but Cascadia Metals assumes no responsibility whatsoever in relation to such information or advice. Please ensure you have the most current Technical Bulletin.
