

## 4.1 Storage and Transport of Hot Dip Galvanized Steel

### 1. General

The excellent corrosion protection afforded by hot dip galvanizing is due to the presence of protective layers on the surface of the zinc. These layers are formed over a period of weeks or months by weathering and consist mainly of basic zinc carbonate the formation of which depends heavily on the presence of carbon dioxide. However, these layers, which are vital for corrosion protection, cannot form if the surface of the zinc is covered for a long period of time with water having a very low or negligible mineral content, or if the air supply, and consequently the amount of carbon dioxide available, is inadequate.

When this happens wet storage stain can form on the surface of the galvanized articles (fig. 1). Wet storage stain consists mainly of zinc hydroxide, a small amount of zinc oxide and a tiny amount of zinc carbonate. Wet storage stain does not have a precisely defined composition as it depends upon the conditions that have produced it.

### 2. Environmental factors

In practice wet storage stain is only a problem on newly galvanized components and as moisture is a vital prerequisite even the seasons of the year can have an effect. The times when wet storage stain increases are autumn and winter. Frequent thunderstorms, fog and low temperatures can bring about its formation.

In many cases, if the temperature frequently falls below the dew point, the resulting condensation will cause wet storage stain. Moist air may condense on cold steel components forming a film of moisture which attacks the pure zinc.

Storing newly galvanized components in wet grass, laying them flat on top of one another, or in a way that air cannot penetrate but moisture can will also result in wet storage stain.

Whilst it is well intended, covering galvanized steel parts stored in the open air with tarpaulins or plastic sheet can do more harm than good. Moist air can accumulate under the covers resulting in condensation – and ideal conditions for wet storage stain. Proper packing with sealed membranes is only of use as long as they remain undamaged and moisture cannot penetrate. In this respect bulk hot dip galvanized goods, such as screws or nails, stored in damp wooden boxes or outside in open containers, are especially vulnerable.

It is important to understand that wet storage stain is not related to the galvanizing process and is not a measure of the quality of the galvanizing. Rather, it is a phenomenon which is totally dependent on the weather conditions during storage or transport of recently galvanized components.

**Fig. 1: A hot dip galvanized water container after storage for several months outside. The tightly packed conditions prevented sufficient circulation of air, resulting in the formation of wet storage stain.**



### 3. Extent of damage

The damage caused by wet storage stain is frequently over-estimated by the layman as its formation comes about by the conversion of quite small quantities of metallic zinc into large quantities of a loose, amorphous, powdery corrosion product (zinc hydroxide). It is possible to distinguish between light and heavy formation of wet storage stain.

**Light** wet storage stain occurs when condensation or moisture has only limited time in contact with a newly hot dip galvanized surface and then quickly evaporates (fig.2). In this case there is sufficient air and the moisture covering is not continuous. The damage to the zinc coating is slight and the thickness of the coating is not seriously reduced. When the conditions producing the wet storage stain are removed, small quantities of zinc hydroxide are converted into the surface layer that protects the zinc. This form of wet storage stain is mainly harmless but it can lead to problems with adhesion of subsequently applied coatings since the hydroxide layer is not tightly adherent to the surface of the zinc.

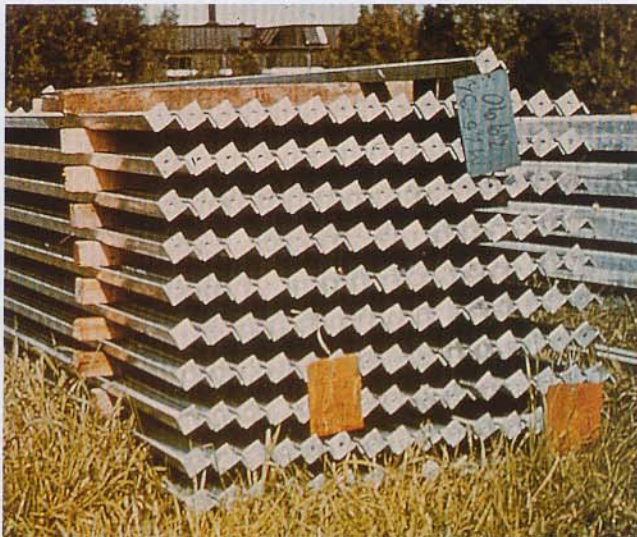
**Heavy** wet storage stain occurs under conditions of continuous and intensive moisture. It can lead to considerable damage to the zinc coating, even to the extent of destroying it completely in places. All zinc corrosion products must be carefully removed before any objective report involving measurement of the remaining coating, or visual examination, can be made.



**Fig. 2: A minimal amount of wet storage stain seen on a signal mast. This is not significant for the galvanized coating. However, it must be removed before any duplex coatings are applied.**



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**Fig. 3: Only half the job ... Carefully stored on timber frames but then left in knee-high grass and with open angle sections pointing upwards.**

- Store at a slight angle, if possible, so that water can run off.
- b) Transport
  - Ensure adequate ventilation and avoid condensation.
  - Do not transport delicate components on vehicles with no weather protection if the weather is wet.
  - If components are to be seafreighted use chemical or wax protection.
  - Do not let galvanized goods come into contact with other goods that may be detrimental (for instance, chemical spillage).
  - Do not transport hot dip galvanized bulk goods, such as nails, in damp wooden boxes or store them in open containers in the open air.

### 5. Repair of wet storage stain damage

Wet storage stain looks worse than it really is. The damage is more aesthetic than physical and it should be remembered that when seen on top of some bright, shiny galvanizing that this will change anyway in the course of the next few months as it weathers.

Wet storage stain will no longer increase once the conditions causing it have been removed. With small amounts it is not absolutely necessary to remove the thin, whitish layer. The corrosion products will slowly be absorbed by the developing surface layers. However, if a duplex coating is to be applied to the galvanizing, every trace of wet storage stain must be removed or else the adhesion of the coating will be affected.

With heavy wet storage stain formation (fig.4) extensive repairs may be necessary depending upon the extent of the damage. If the remaining zinc coating is found to conform to the minimum standard requirement, then it is only necessary to carefully remove the whitish layer. However, if the minimum average coating weight does not meet the standard then specialised repair work must be carried out to provide corrosion protection at the affected spot. The various ways of doing this are given in BS 729:1979 (1986) and the forthcoming European specification for hot dip galvanizing.



**Fig. 4: A large area of wet storage stain clearly showing local corrosion of the base steel.**

### 4. Prevention of wet storage stain

As the formation of wet storage stain is caused by the effects of moisture combined with storage conditions, all preventative measures are aimed at eliminating these causes. Some advice is shown below:

- a) Storage
- Do not store newly galvanized components in the open air for long periods in conditions of rain, fog or high humidity.
  - Lengthy exposure to snow can also produce wet storage stain, so store delicate components under cover.
  - Do not store galvanized components in tall, damp grass, in puddles or in mud (fig.3).
  - Keep steel components clear of the ground by putting pieces of timber etc. underneath them. Ideally, a clearance of 150mm is needed.
  - Do not use tarpaulins or plastic sheets for covering (possible condensation).
  - Avoid condensation traps when storing sections. Point open sections downwards.
  - Do not allow surfaces to touch (use wooden spacers if necessary).