nordic GALVANIZERS

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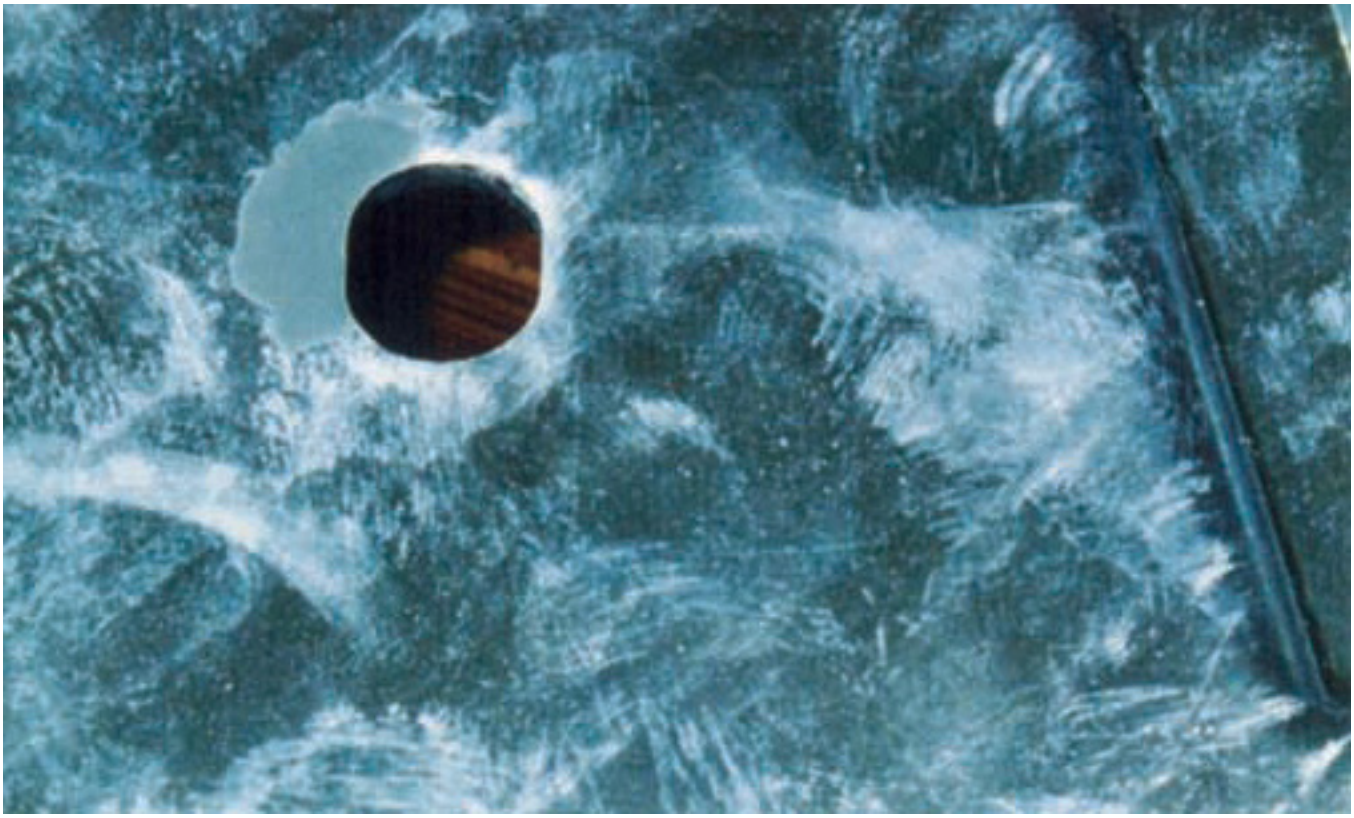
Repair of damages in zinc layers



Example of repair to zinc flaking around a punched hole in a hot dip galvanized plate. Zinc-dust paint was used to carry out the repair.

Although galvanizing provides a tough and durable corrosion protection the need to repair the layers sometimes occurs, to fulfil the corrosion protection requirements and also the product's appearance, in case this is important.

The need for repairs can also arise due to to welding or any other further processing of galvanized steel or be associated with flaking, which can be difficult to avoid completely when handling and transporting heavy goods in particular.

This information sheet describes the methods generally used for carrying out repairs and provides instructions on how to perform it. The information sheet also describes the requirements and guidelines specified by the standard EN ISO 1461 for carrying out repair work.

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1. Carrying out repairs according to EN ISO 1461

Section 6.3 in the standard states that the following repair methods can be used:

a) Spraying with zinc
b) Applying zinc-rich paint
c) Applying low-melting zinc solder

The standard's text only mentions repairing bare spots, i.e. spots where no zinc coating has been formed during hot dip galvanizing. Possible causes of the bare spots are varnish, paint or another impurity which cannot be removed during the normal pre-treatment processes carried out in the hot dip galvanizing line. Air pockets created due to lack of, or wrong placed, venting holes can also cause bare spots.

Annex C, section 5, which is for information only, states that damage and zinc flaking should be repaired using the same methods and according to the same guidelines which apply to bare spots.

The standard specifies the following repair requirements:

1. Bare spots must not exceed 0.5% of the total surface area of the individual component.

2. Each bare spot must not exceed an area of 10 cm^2.

3. The repair will include descaling, cleaning and any necessary further treatment to ensure adhesion.

4. The coating on repaired areas will be capable of giving sacrificial (cathodic) protection to the steel.

5. The layer thickness on repaired areas must be a minimum of 100 µm, see EN ISO 1461, unless otherwise agreed.

6. If the purchaser stipulates special requirements, e.g. a paint coating is to be subsequently applied to the components after hot dip galvanizing, the galvanizer will advise about the repair method which will be used. The purchaser should then ensure that the paint system is compatible with the repair methods and materials used.

2. Repair methods

2.1 Applying zinc-dust paint

Paint types

Zinc-dust paints comprise fine metal zinc powder in a binding agent which can be air-drying and hardening (one-component) or drying and chemically hardening (two-component). The metal zinc content in the dried paint film should be a minimum of 90% by weight.

Air-drying and hardening zinc-dust paints are mostly used for repairing small areas of damage in the zinc coatings. Chemically hardening zinc-dust paint - such as epoxy - is also used, but is subject to the Danish Working Environment Authority's executive orders[1,2,3)].

Zinc silicate paint will usually be less suitable for carrying out repairs as its durability is heavily dependent on how clean and rough the underlying layer is and on the temperature and air humidity during hardening.

The paint is applied to the repair area and the zinc coating's adjacent edges using a spray or brush in several layers until the specified layer thickness is met. A brush is mostly used for carrying out minor repairs.

The treatment must only be applied to surfaces which are completely dry and at temperatures above 5˚C. The paint manufacturer's specifications in terms of the conditions for applying the paint and how frequently repainting should be carried out must be observed.

Repairs to hot-dip galvanized steel which is to be painted must include a separate underlying layer to be treated with paint. The galvanizer should therefore be advised whether the steel is also going to be painted, in which case it should be agreed how any damage to the zinc coatings will be repaired.

Pre-treatment - painting

The pre-treatment process prior to painting includes, if appropriate, the removal of oil or grease, as well as cleaning and raising the surfaces by sandblasting or rubbing them. The surfaces are cleaned to remove blast or abrasive dust prior to painting.

Sandblasting is used to repair large areas and produces the best adhesion and durability for painting. Cleaning is performed to standard Sa 2 1/2 according to ISO 1801-1:1988. The edges of the adjacent zinc coating are matted during sandblasting by using a lower blast pressure or by rubbing with a rough abrasive as indicated below. Damage to the adjacent zinc surfaces is avoided by using cover plates made of rubber or a similar material.

Rubbing is carried out using rough abrasives (~ 40 grit) to produce a bright clean surface in the damaged area. The zinc coating's edges alongside the damage are matted just like during rubbing.

In the case of mechanical rubbing, a low rotation speed is used (max. 200 rpm) in order to achieve a good level of roughness and avoid tarnishing as a result of generating heat and flaking paint later on.

2.2. Spraying with zinc

Spraying or coating with zinc, as it is also known, is carried out using a spray process where a zinc coating is applied to the component. The coating can be applied at the desired thickness which, depending on the application, is typically 40 to approx. 200 µm.

The treatment is carried out using a spray gun where a piece of zinc wire is melted in a gas flame or electric arc and is applied to the cleaned steel surface using compressed air. The small particles of melted zinc are radically deformed when they touch the surface of the component and are bound mechanically to the underlying layer.

This is considered to be a cold method as the surface of the component, depending on the thickness of the steel, is only subject to temperatures of up to approx. 150˚C.

Spraying is usually used on larger repair areas and is carried out in such a way that the edges adjacent to the galvanized area are covered. The coating has the same good anti-corrosion properties as hot dip galvanizing, but should be applied, due to a certain degree of porosity and a slightly faster corrosion speed, at a thickness in excess of the layer thickness used in the hot dip galvanizing process. EN ISO 1461 stipulates that the metal coating should be applied to a minimum layer thickness of 100 µm.

Spraying has the advantage over painting in that it can be

carried out in a single work operation. Paint will be applied in several layers with intervening periods for drying and hardening so as to achieve a sufficient thickness and durability for outdoor use.

Pre-treatment - zinc spraying

Pre-treatment is carried out by sandblasting using grit at a minimum of Sa 2 1/2, as specified during pre-treatment before painting. According to previous guidelines, sandblasting would produce a surface roughness of Medium (G) Grade based on ISO 8503-1:1988 (~Ra 12 1/2 µm). Subsequent analyses have shown that a surface roughness with a sharp-edged profile equivalent to Fine (G) Grade, see the ISO standard, is sufficient and that this enables the metal coating layer to meet a minimum adhesive power of 5 N/mm^2 measured using the pull-off method with a Säberg tensile adhesion tester or similar device.

The zinc coatings' edges alongside the repaired area are bevelled and matted completely by rubbing using a rough abrasive, approx. 40 grit.

2.3. Further treatment and appearance

It may be necessary to apply further treatment to the repaired areas on easily visible surfaces where appearance is considerably important, with a finishing coat, if the appearance is the same as that of the galvanized area. However, it should be pointed out that it cannot be expected to achieve a complete match in terms of colour and lustre and that the surrounding galvanized area changes appearance over time.

Zinc surfaces which appear bright and have a metal sheen immediately after hot dip galvanizing will subsequently become matt and light grey when they are regularly subject to dampness when used outdoors. Zinc surfaces which are matt and fairly grey will also gradually become slightly darker in outdoor conditions.

Zinc-dust paint comes in various matt grey colours, depending on the make. This means that the appearance of the repairs is a sufficiently good match in some cases with the galvanized coating, whereas a suitable finishing coat needs to be applied in other cases.

Spraying on the coating produces a matt, light-grey zinc coating with a slightly rough surface. The appearance can be changed using the paint types mentioned in Section 2.1, or with paint which also happens to be suitable for hot dip galvanizing or spraying.

Both when carrying out a repair with zinc-dust paint and when spraying with zinc, the repaired area should be smoothed slightly so that the surface and junctions with the galvanized area are even. The finishing coat is applied immediately after smoothing.

2.4. Applying low-melting zinc solder

The repair can be carried out with a number of low-melting alloys containing zinc. This method entails problems with the metal solder reaching a sufficient thickness in larger areas, which will result in the coating becoming not durable enough. This method can be used on small damaged areas of 1/4 - 1/2 cm^2, where it is easier to achieve good thickness.

In the case of structural parts which are subject to tensile strain, examples have been seen of cracks developing when the zinc solder infringes the steel's grain boundaries. Therefore, this method is not recommended to be used for parts subject to strain, including in particular welded joints and their immediate surroundings.

Carry out repairs as follows:

1. Remove any oil and grease from the repair site and remove any rust by rubbing.
2. Warm up the area to the solder's operating temperature.
3. Use a wire brush on the area which has been warmed up and add separate flux material, if appropriate.
4. Wipe the solder against the hot surface.
5. Distribute the melted solder evenly with a filling knife and remove any excess solder.
6. Remove any flux material residue by washing with water.
7. Use a fine file or fine abrasive paper to remove any irregularities on the surface.

3. Selecting a repair method

You should select and apply a method which ensures that the protection against corrosion is not reduced considerably in relation to the galvanized area. However, you should be aware that you cannot expect to achieve a complete match visually between the repair and the galvanized area. You should carry out the work, taking into account the corrosion environment and the stresses which the hot dip galvanized structures are subsequently exposed to. Further information about the different methods used for corrosion protection and about performing and applying them in the individual corrosion categories is described in the literature [4,5,6,7)].

The repair methods described in Section 2 are generally used to repair damage to hot dip galvanized steel in Nordic countries, but there may be some difference in which method the individual hot dip galvanizing company chooses to use to carry out repairs. The purchaser should therefore contact the galvanizer and agree on how the repairs are to be carried out, whether there are special requirements for this, e.g. whether the components need to be painted after hot dip galvanizing.

Generally recommended and applied guidelines for repairing hot-dip galvanized steel according to the size and nature of the repaired area are given below.

3.1 Repair instructions

Damage to the zinc coatings in the form of zinc flaking, which occurs in the event of bumps and knocks sustained by the component's surfaces during handling, transport and assembly, and of bare spots or other damage where the steel surface is exposed or the thickness of the zinc layer is significantly reduced, should be repaired as specified below:

3.1a Damage where repairs are not required

Damage in the form of small, circular zinc flakes up to 5 mm wide, which typically occur at the sides and corners of components will be afforded cathodic protection by the surrounding zinc layer, which is why a repair is not required [5)] to ensure corrosion protection. The steel surface subject to continuous zinc flakes less than 3 mm wide, which can appear at the edges of the component etc., will also have cathodic protection.

3.1b Repair using zinc-dust paint

Zinc flaking and damage which exceed the limit mentioned under section 3.1a but have an area smaller than 10 cm^2 are repaired with zinc-dust paint.

Repairs are carried out by rubbing the damaged area and

applying zinc-dust paint in several layers to a minimum dry film thickness of 100 µm, as specified in Section 2.1.

3.1c Repair by spraying on a zinc coating

This repair method is used for damaged areas exceeding 10 cm^2. The repair is carried out by sand blasting and applying a zinc coating to a minimum layer thickness of 100 µm, see EN ISO 1461.

3.1d Appearance, further treatment

In the case of surfaces whose appearance is important, there may also be an additional requirement to apply further treatment with a finishing coat, as specified in Section 2.3. However, the purchaser should inform the galvanizer of this prior to placing the order.

References

1. Danish Working Environment Authority's Executive Order No. 199 of 26 March 1985: Executive Order on Epoxy Resins and Isocyanates etc.

2. Danish Working Environment Authority's Executive Order No. 779 of 15 October 1999: Executive Order on Amendment to Executive Order on Epoxy Resins and Isocyanates etc.

3. Danish Working Environment Authority's notification no. 3.01.3 of June 1988: Epoxy Resins and Isocyanates.

4. Standard EN ISO 12944-2: Corrosion protection of steel structures by protective paint systems. Classification of corrosion categories.

5. Dansk Standard Recommendation DS/R 454, Teknisk Forlag, Copenhagen (1982).

6. Handbook i rostskyddsmålning [Handbook on anticorrosive paint], Bulletin no. 107, Swedish Corrosion Institute, Stockholm (1999).

7. H. Reitz et al., Overfladebehandling af Stål [Surface treatment of steel], 1st edition, DTI-Forlag, Copenhagen (1993).

A 6 mm-wide cut groove through a 60 µm-thick zinc coating on steel and exposed for 5 years in a heavy industrial environment in Holland. Note the coating of zinc salts in the groove which has not been attacked by corrosion. (Photo: J F H van Eijnsbergen).

If you have any questions, please contact:

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