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Continuous Galvanized Steel Sheet

Corrosion Library

Selected Corrosion Issues Received by the GalvInfo Center as of:

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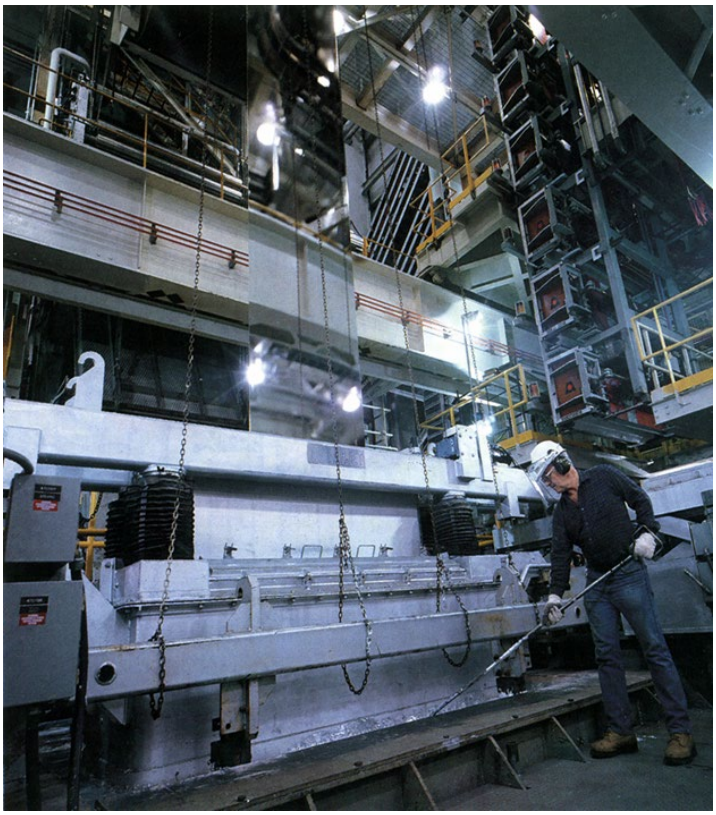

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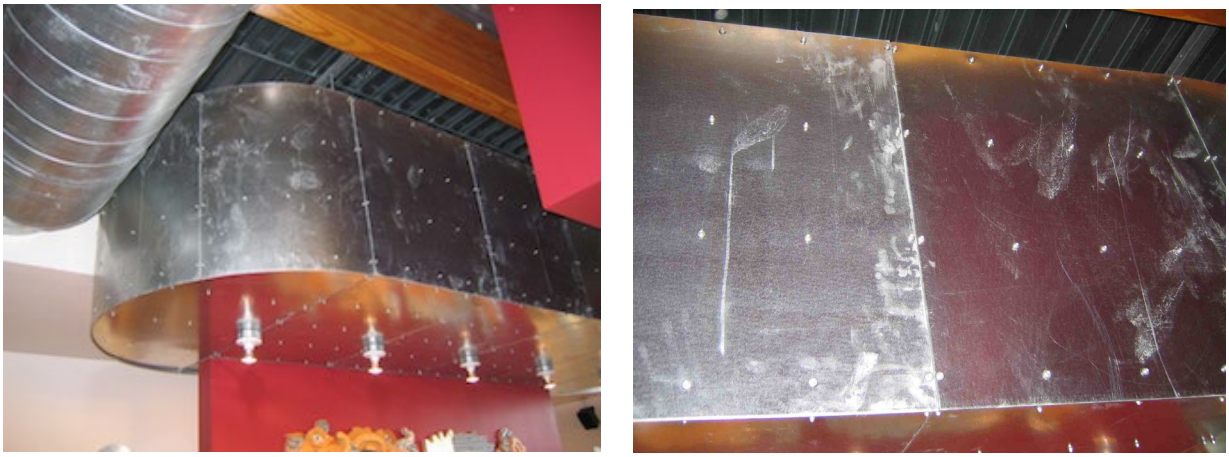
Section 1: Corrosion – General

1.1 Fingerprinting



Fingerprinting on galvanized HVAC assembly (October 2004)

Perspiration from workers can dissolve some of the passivation film, allowing salt to react with the zinc, leaving the fingerprinting marks. These white stains are not entirely removable. Application of phosphoric acid may even out appearance but will dull the entire surface. An oxalic acid cleaner, "Bar Keepers Friend" is reported to be able to almost remove these stains.

***Prevention**: Use acrylic coated galvanize "Plus", or workers should wear gloves and long sleeves.*

Fingerprinting on galvanized electronic equipment panels (November 2009)

Corrosion was seen on galvanized electronic equipment panels/frames after ocean vessel shipment from Asia. The initial concern was that water damage occurred in transit. The above

photos of the condition, however, have all the appearances of fingerprinting describe above that most likely occurred during assembly and/or handling of the equipment.

***Prevention**: Use acrylic coated galvanize "Plus", or workers should wear gloves and long sleeves.*

More information – see http://www.galvinfo.com/galvinfonotes/

2.13 Treatments for Resistance to Handling and Fingerprint Marks

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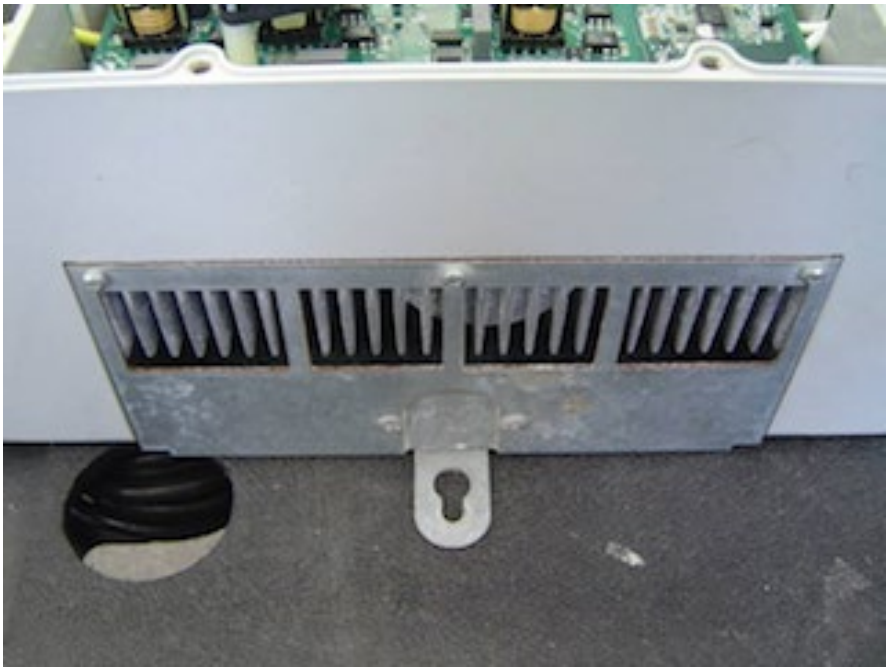
1.2 HVAC Ductwork Corrosion

Corroded residential ductwork (March 2005)

The galvanized ductwork in the entire basement of a private home mysteriously corroded to the point of red rust in some locations. As the photo below shows, it was attacked by an aggressive substance. Apparently, there was a small roof leak that entered one register, but the extent and severity of the damage is inconsistent with plain water coming in contact with the ductwork. One possibility is that the leaking water dissolved aggressive chemicals from the wood in the house before it reached the zinc.

***Prevention**: Avoid water getting into ventilation ducts, as much as that is possible.*

1.3 Cut Edge Corrosion



Cosmetic rust on the sheared edges of 0.080” G90 in a greenhouse environment (March 2009)

The concern was the rust on the shear-cut edge, and would a heavier coating prevent it. In such an environment, edge rust would always occur on sheet as thick as this, but it would not progress beyond the extent in the above photo until the nearby zinc was consumed. A thicker zinc coating would delay this.

***Prevention**: To completely prevent edge rust, post HD galvanizing would be necessary. Painting the edges with zinc-rich paint would delay it significantly.*

More information – see http://www.galvinfo.com/galvinfonotes/

3.6 Galvanic/Bimetallic (including Cut Edge) Corrosion of Galvanized Sheet

1.4 Corrosion Due to Soil – Case 1

Corrosion on galvanized flashing close to the ground on a stucco wall (April 2010)

A corrosion problem encountered on G90 flashing at the bottom of stucco walls in resort buildings in California. Corrosion is proceeding from the bottom up. "Beach marks" in the white corrosion product indicate cyclic attacks, similar to fatigue crack failure. It is likely related to soil chemistry and repeated wetting events from both irrigation and rain.

Prevention: *Soil near the base of a wall should be covered with stones or paved over to prevent moisture splashing on the flashing during irrigation or rainfall.*

More information – see http://www.galvinfo.com/galvinfonotes/

6.2 Successfully Designing Products made with Galvanized Steel Sheet

1.5 Corrosion Due to Soil – Case 2

Soil-side corrosion on culvert pipe (January 2012)

Soil-side corrosion in culvert pipe after 3 years. The pipe was laid in cement-stabilized sand and the corrosion revealed itself after a flood that washed some of the sand back from the end. The environment against the outside of the pipe must have been constantly wet to get such a degree of corrosion in such a short time. It may just be a condition close to the end of pipe due to dripping.

Prevention: *Unknown. Due to the myriad types of soil conditions that exist, viz., widely varying chloride and moisture contents, and pH levels, the solution to corrosion issues of galvanized sheet in soil are difficult to determine*

1.6 Chloride Corrosion on Exposed HVAC Ducts

Surface of G90 HVAC located about 1 mile from the coast of Western Australia (October 2015)

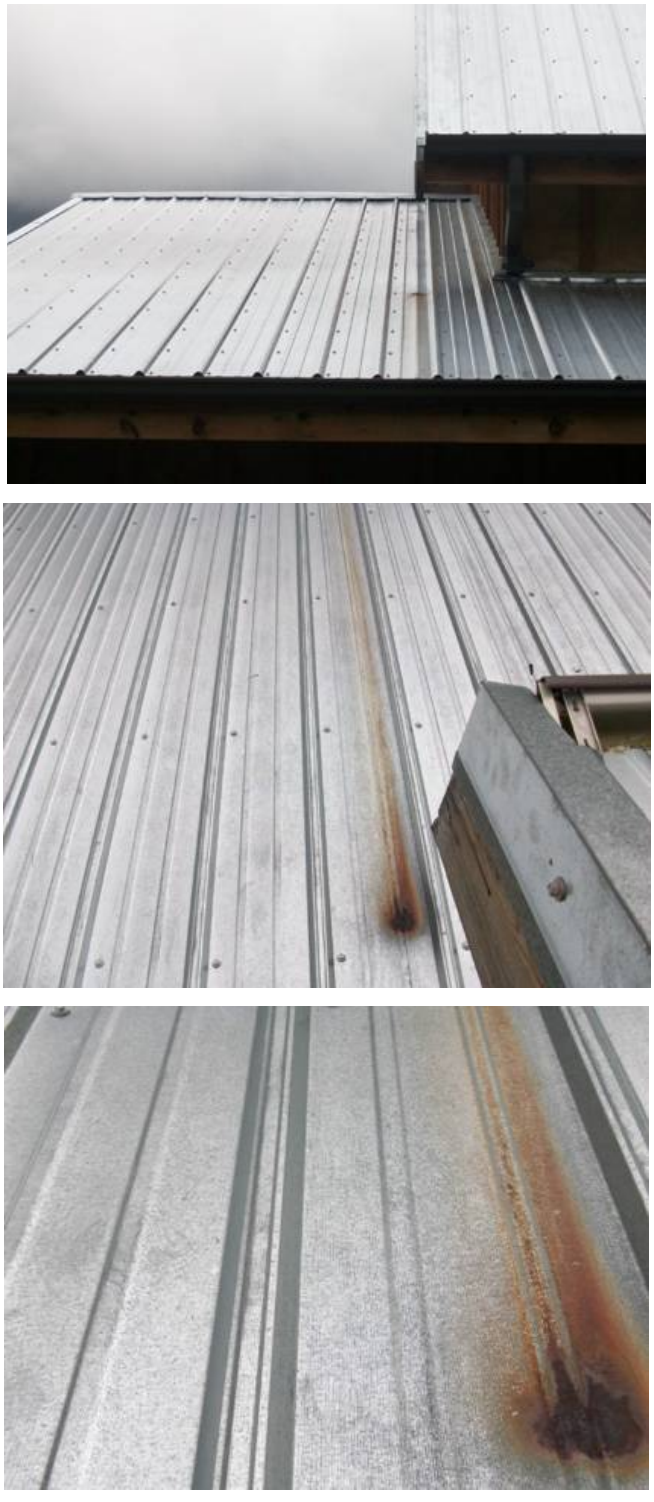
The photos illustrate red and white rust in G90 HVAC piping installed about a year earlier on a building about a mile from the west coast of Australia. About 2-3 months before the photos were taken a cyclone passed through the area. The rust was noticed about one month after that. The supplier said the red colour was nothing more than surface iron from annealing in the mill and the underlying zinc and steel were unaffected. That was an incorrect assessment. The photos showed very aggressive, likely chloride, attack of the zinc. This may be an environment that is too aggressive for G90.

Prevention: *In designing equipment that will be boldly exposed to a potential severe chloride environment, chose a material that can stand up to the conditions.*

More information – see http://www.galvinfo.com/galvinfonotes/

1.6 Selecting Coating Thickness (Weight of Mass) for Galvanized Steel Sheet Products

1.7 Accelerated Roof Corrosion from Runoff



Rusted area from water draining off a wood fascia (May 2010)

Especially on a roof, a very small amount of zinc is dissolved by rainwater and removed during each wetting event. If some portion of the roof receives extra water, draining from some higher, non-zinc coated surface, that extra water also takes its share of zinc (in addition to that taken by the rain that fell directly on it). The end result is the area of impingement has its zinc coating removed at a much higher rate, aided by erosion from falling water, and the corroded area gradually grows in size.

Prevention: *In designing a structure, it is important to ensure that a particular exposed metal surface (roof elevation, side wall, etc.) always "sees" the same weather as uniformly as possible across the entire area. The above problem could have been avoided by cladding the wood fascia board with galvanized sheet. Water dripping off it would already be saturated with "its share" of zinc and would not have created the rust spot.*

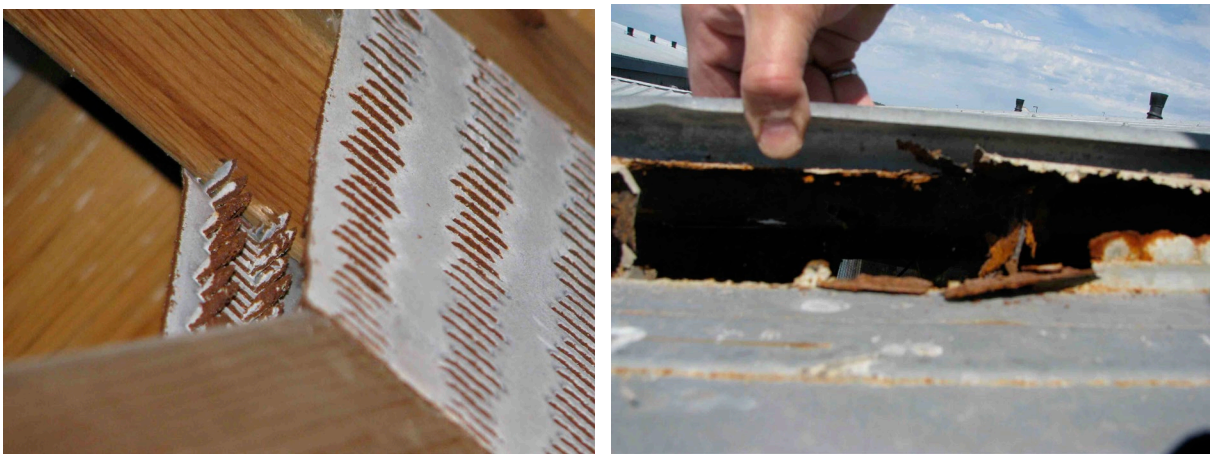
1.8 Accelerated Erosion Corrosion of Solar Panel Support Frames

Corrosion of galvanized support of aluminium-framed solar panels (July 2018)

The downward and left to right tilt of the solar panels results in all the rainwater falling on a single panel draining to the lower right corner of the aluminum frame, then spilling onto one small area of the galvanized steel support rail. This accelerates the removal of the zinc coating from this one spot and the surfaces below it, due to the lack of any zinc in the water coming off the glass and aluminium panel. The stream of water concentrated over such a small region also accelerates erosion of the surface.

Prevention: *This situation could have been avoided by either using aluminum support frames (perhaps not economical), or providing a drain channel/spout directing water away from the galvanized frame. To remedy the problem on the current structure, one method would be to repair the rusted areas with zinc-rich paint or thermal zinc spraying, then install replaceable zinc coated "splash pads" over the areas to receive the drain water and direct it away from the frame. These could be made from G165 or G185 galvanized sheet to last longer before needing to be replaced.*

1.9 Building Corrosion from Excess Condensation



Corrosion in 3-Year Old Animal Confinement Building – Western Canada (August 2010)

The above two photos were taken from the same three-year-old animal confinement building. The G90 truss plates on the roof trusses (left photo) were severely corroded and the nearby roof sheeting had large perforated areas (right photo) that initiated from the inside. The cause of this very severe corrosion was quite likely an extreme build-up of very moist air laden with chemicals from animal waste products. During cold winter weather, a very corrosive condensate formed on exposed metal surfaces high in the structure, resulting in the aggressive attack shown in the photos.

Prevention: *Have a building design that has sufficient and adequate ventilation, such that moisture cannot build up to the point where it can condense inside a structure. The exhaust system must both remove the moisture-laden air from inside the building, and not allow it to be entrained with replacement air.*

More information – see http://www.galvinfo.com/galvinfonotes/

6.3 Successfully Designing Products made with Galvanized Steel Sheet

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1.10 Building Roof Corrosion from Debris on Surface

Corrosion on Farm Building Roof (August 2010)

This photo shows the result of dust residue from an animal feed chute collecting on the roof. After being wet for weeks or more, corrosion cells form.

Prevention: *The removal of loose debris such as leaves, dirt or building effluent (grain dust or chaff around roof vents), etc., is important. Even if these residues do not contain corrosive chemicals, they still become wet, which prevents the quick drying and allows corrosion cells to set up. Zinc surfaces must be kept free of debris build-up by regular maintenance.*

More information – see http://www.galvinfo.com/galvinfonotes/

6.4 Successfully Maintaining Products made with Galvanized Steel Sheet

1.11 Corrosion on Utility Trailer with Galvanized Sidewalls

Corrosion on Galvanized Trailer Sidewalls (January 2018)

These photos show corrosion on the lower sidewall areas of a galvanized trailer, after transporting one load of loose coal. Note the attack is most severe on the flange where the sidewall is affixed to the wood floor (left photo). Coal contains 1–2% sulphur and is also hydroscopic. What likely happened was the wood floor was damp, allowing coal near it to absorb water. The sulphur in the coal reacted with the water to form small amounts of sulphuric acid, which quickly attacked the zinc. Sulphuric acid is very aggressive towards zinc.

***Prevention**: If coal is conveyed in a galvanized trailer, the entire trailer should be galvanized, including the bottom. Also, the coal must be dry, and the load covered to prevent it getting wet during transit.*

Section 2: Bimetallic Corrosion

2.1 Corrosion of Air Conditioner

Galvanic corrosion of A/C unit galvanized end-plates and frame (October 2004)

A roof A/C unit showed severe corrosion of galvanize end plates and frame after only 5 years on a roof in Indiana. Note the copper cooling tubes are in direct contact with the galvanize end plates. Also, the effluent-bearing copper ions run onto the galvanized frame.

***Prevention**: Copper must be electrically isolated from zinc, and water that has washed over copper cannot come in contact with zinc.*

More information – see http://www.galvinfo.com/galvinfonotes/

3.6 Galvanic/Bimetallic (including Cut Edge) Corrosion of Galvanized Sheet, and

6.3 Successfully Designing Products made with Galvanized Steel Sheet

2.2 Cutting Debris (Swarf) Causing Corrosion on Prepainted Roof Panels

Red rust on top of prepainted roof panels (March 2014)

The above photos show red rust on a prefab building clad with roll formed, standing seam, prepainted sheet. The on-site work was the placement of A/C units on the roof. The contractor claimed no grinding or sawing was done to create debris that could rust, saying the panels must be defective. The photographs below show the nature of the condition. It is obvious, that regardless of the contractor's claim, what certainly looks like metallic debris has rusted on top of the paint.

***Prevention**: Insist that contractors are aware of the absolute need to do same-day complete clean-up and removal of metal cuttings (swarf) after work done installing, repairing, or other operations on or above a metal-clad building roof.*

More information – see http://www.galvinfo.com/galvinfonotes/

4.2 Prepainted Metallic Coated Sheet for Building Panels – Assuring Good Performance, p. 7

2.3 Bimetallic Corrosion on Roof Structure

Corroded galvanized roof structure in Denver (August 2017)

The uncoated angle iron along the top edge of the wall is the source of bimetallic corrosion, because all water that drains down for it carries iron ions, which then attack the zinc from the surface.

***Prevention**: Do not let water drain from a non-zinc surface on to galvanize. In the above situation, the angle iron at the top should also be galvanized.*

More information – see http://www.galvinfo.com/galvinfonotes/

3.6 Galvanic/Bimetallic (including Cut Edge) Corrosion of Galvanized Sheet, and

6.3 Successfully Designing Products made with Galvanized Steel Sheet

Section 3: White and Dark Corrosion Staining

3.1 White Rust on Wood Connectors

Corrosion of galvanized connector plates used as an anti-split device for ACQ treated planks (October 2005)

The plates are made using G185 and show white rust after 2 weeks in banded bundles of planks. When stacked, the connector plates were probably in contact with each other and white rust formed after they got wet. Also, increased galvanic corrosion from the large cut edge area resulting from the oblong holes accelerates the rate of zinc consumption.

Prevention: *The planks should be stacked either the plates cannot contact each other, or that plastic placed between the plates.*

3.2 White Rust on Grain Bins

Storage stain on grain bin panels 3 years after erection (July 2010)

Grain bins with some panels showing severe white rust that was beginning to show red rust. A lawsuit against the supplier and/or erector was being considered. The panels had been stored outside for several weeks waiting to be erected in the fall of 2007. A painter had recently brought the rust to the attention of the farmer – it had not been noticed earlier! It is most likely that this damage had occurred in 2007 as a result of water damage. The affected panels were stained at the time of erection and should not have been installed. It is not the fault of the material.

Prevention: *Grain bin panels are shipped to the field as curved, roll-formed panels. Typically, they are stored outdoors at the erection site. They should be stored CONCAVE SIDE DOWN to allow water drainage. Also, the erector should also be instructed to fabricate the bins as soon as possible.*

More information – see http://www.galvinfo.com/galvinfonotes/

2.10 Imparting Resistance to Storage Stain, and

3.2 Protecting Galvanized Steel Sheet from Storage Stain

3.3 Storage Stain – From Outdoor Storage

Panels installed at the building site (December 2012)

Close-up of storage stain on panels

The covers for an outdoor conveyor line had white rust present when installed in early December. The packaged curved panels had been stored in an outdoor yard in Houston since April 2012. The photo showing the hoods in place indicates that the white rust condition may not be too severe. Actually, they have stood up quite well for having been shipped unprotected and stored outdoors for so long. There are two reasons for this. First, they were shipped, and stored with the panels vertical, so bulk water drained away

quickly. Had they been stored concave side up, it would have been a much worse. Second, the flange on each the side of the hoods kept the nearby surfaces from touching each other. That is why the white rust is only in the centre 1/3 of the hoods, as that is where the surfaces touched, where water could remain in contact with the surface, and would take a long time to dry. There are two hoods in the second photo that do not have any stain. They were probably the outer one in a package.

The chances are good that this material will be serviceable. Exposed to the atmosphere, the white rust will disappear and the zinc will do its normal job of protecting the steel against red rust. White rust on the inside will take longer to dissipate, but it's not visible and will not get worse.

Prevention: *One thing the manufacturer could have done is put narrow plastic spacers 1/2 way around the circumference between the panels to keep them from touching. Shipped and stored like that, these panels could stay outdoors for years if needed with no water damage, because it's little different than a panel on a building. If galvanized parts must be stored outdoors, then making sure all surfaces have access to the atmosphere and can drain well is critical to avoid storage stain.*

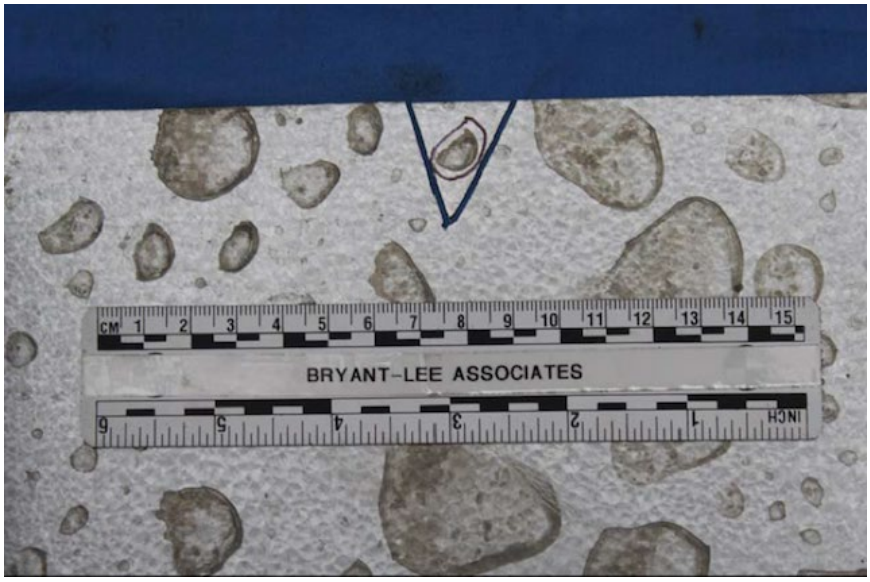
More information – see http://www.galvinfo.com/galvinfonotes/

2.10 Imparting Resistance to Storage Stain, and

3.2 Protecting Galvanized Steel Sheet from Storage Stain

3.4 Staining on 55% Al-Zn Products

Black storage stain on installed framing (September 2013)

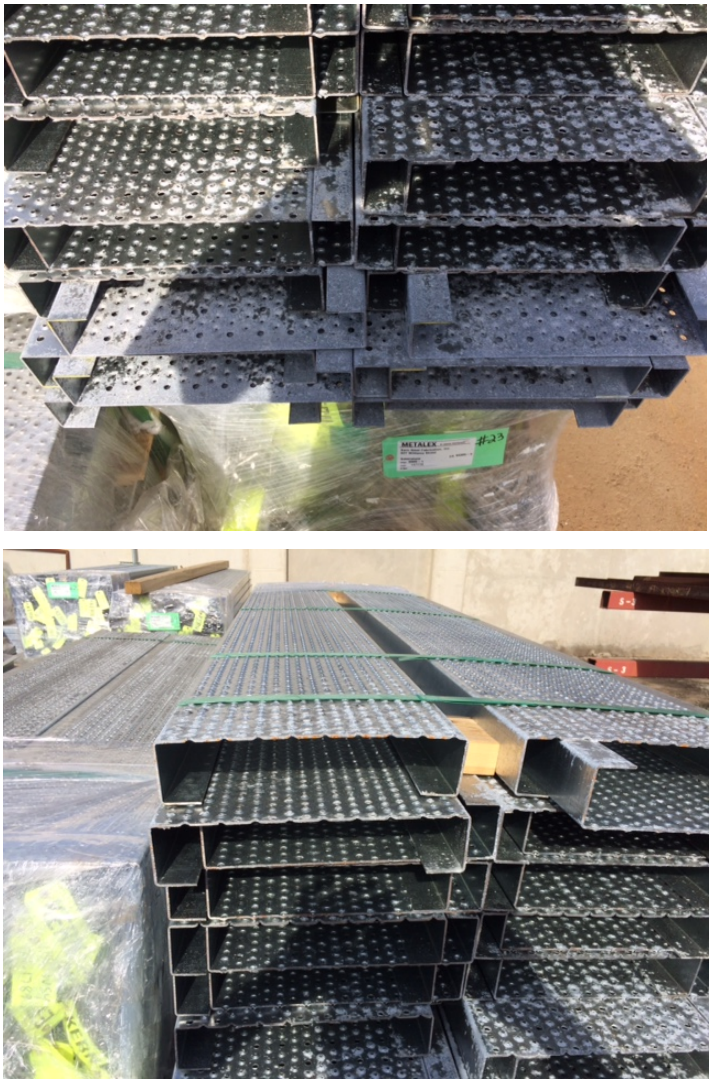


Dried stain on installed AZ standing seam roof panels (September 2013)

The first above depicts black storage stain on installed framing members. It is most likely that such severe staining happened prior to installation. The second photo shows dried stain that was on two adjacent installed standing seam roof panels where the rest of the roof was stain-free. The pattern looks like a liquid had been spilled, beaded and then dried. EDX analysis had picked up potassium and chlorides.

Prevention: *Installers should be trained not to install badly stained framing members.*

3.5 White Rust on Perforated C Channels



White rust on perforated C channels (February 2015)

Produced from galvanized sheet, which had been perforated and rolled formed. Material stored outside, or subject to severe wetness during transit, should not be stored in that condition. White rust occurred because water sat on the surface for an extended time. Zinc is a good protector when normal wet dry cycles are in play. When it's subjected to long times of wetness the corrosion mechanism changes. Thick white zinc hydroxide/oxide forms, rapidly consuming the zinc.

Also, the bundles could not drain properly. The dimples (convex top and concave bottom) around the perforations made draining even harder as the water would tend not to run off even if the bundles were slightly sloped. Water also appears to have been trapped under the plastic. The

perforations exposed much more edges than on non-perforated panels (by an estimated factor of 6 to 7). In a wet state, the zinc was then doing double duty, sacrificing itself near the cut edges to protect the steel from rusting, and being rapidly consumed by the constant state of wetness.

Prevention: *The bundles, if received wet, should have then been oriented to be on at least a 20-degree angle to allow better drainage, and preferably each bundle should have been broken open and all the members separated and allowed to drain and dry. In short, this material somehow got wet and was left in that condition long enough for white rust to form. I was not the fault of the material.*

3.6 White Rust on G90 Purlins

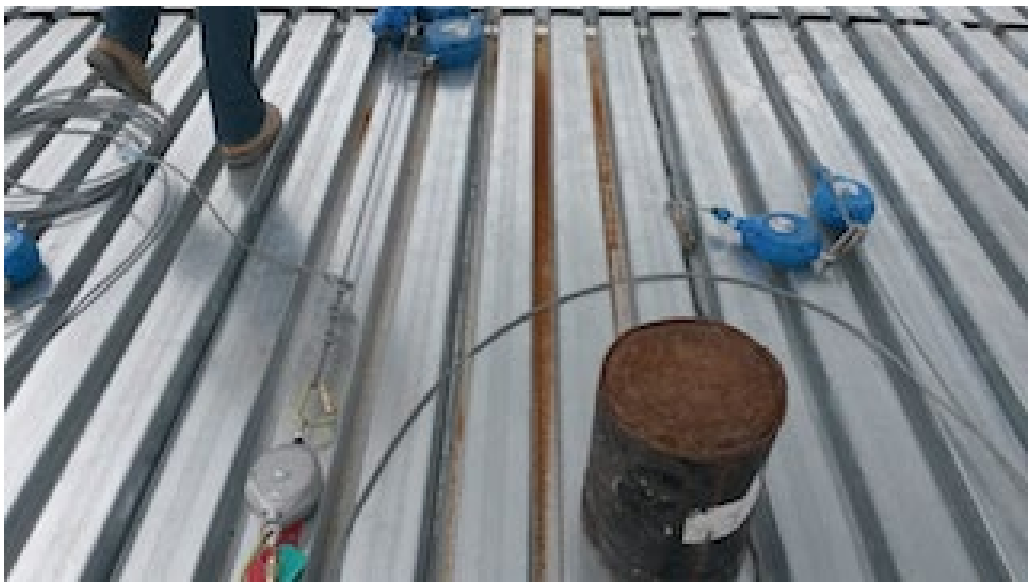
White (and red) rust on G90 purlins stored outdoors (July 2015)

Storage stain on G90 purlins stored outdoors in North Carolina. The staining appears to be related to roll forming solution left on the surface when packaged, aggravated by outdoor storage. The photo shows red rust in the center of one white stain patch. The pattern suggests aggressive corrosion not necessarily due to water coming in from the edges of the purlin, but from liquid already present.

Prevention: *Roll-formed galvanized sheet should be free of excess rolling lubricant before being bundled.*

3.7 White and Red Rust on Roll-Formed Roof Panels

White and red rust on roof decking (October 2015)



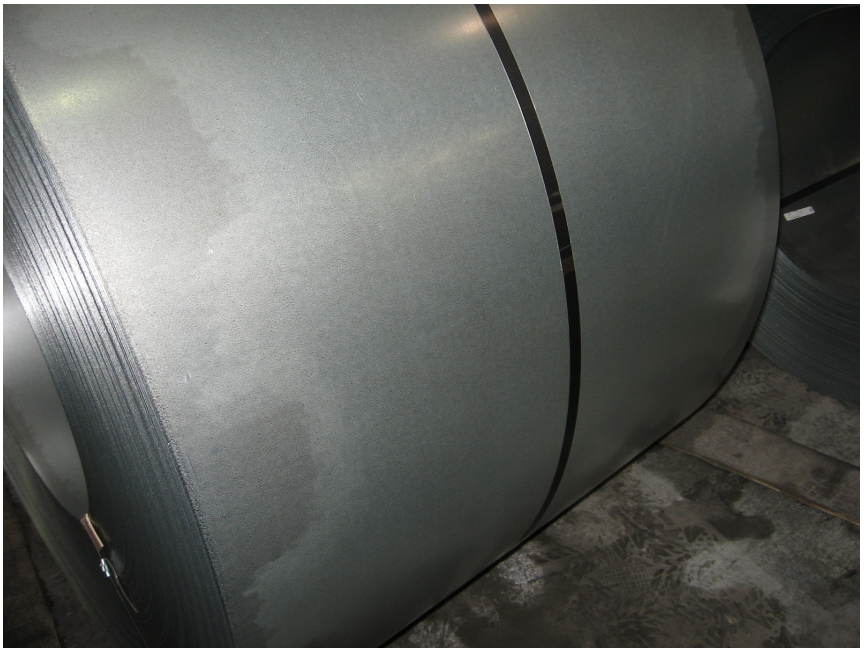
Red rust on the bottom channels of roof decking

Corrosion on roof deck panels in Panama, which is the result of water damage during transit and/or storage. In the top photo, the red rust in the channel was where two surfaces were probably touching in the stacked bundles. It was wet long enough for the zinc on the side of one channel to be consumed allowing red rust to form. In the second photo the bottom of some channels have extensive red rust, indicating that water was sitting there for considerable time.

Galvanized sheet cannot be expected to survive such treatment, especially in a warm, humid environment such as Panama.

Prevention: *Roll-formed galvanized sheet in bundles must be protected from water damage.*

3.8 Dark Storage Stain resulting from Condensation



Dark storage stain attributed to condensation on the coil edge “wicking in” between the laps (September 2016)

The material in the above photo is skin passed galvanized sheet where the zinc surface was smoothed by temper rolling. This stain is not the typical white rust seen due to condensation damage on regular galvanize sheet but has a dark appearance that can be mistaken for staining due to something else, such as chemical treatment or oil. These dark stains have been confirmed to be zinc oxide. A recent study (2020) found that the velocity of Al-based oxide segregation on the surface of temper-rolled HDG was much higher than that on HDG without temper rolling. This was attributed to the surface areas affected by the temper rolls having much more Al-based oxides present due to the Zn crystal grains in the coating being refined by the slight cold reduction, creating an increased number of grain boundaries that can serve as Al diffusion paths. It has

long been known that non-temper rolled galvanized sheet has Al-based oxides present on the surface. The study found that on freshly coated galvanize this level was 2 mg/m^2, rising to a stable level of about 3 mg/m^2 after 12 weeks aging at 20˚C. The Al oxides were found primarily at the grain boundaries of the zinc. For the temper rolled material, the Al-based oxides measured at about 7 mg/m^2 after the same aging time, were still on an upward trend, and were also present at locations away from the grain boundaries.

The above may help explain the reason for the dark appearance of storage stain on temper rolled galvanize. It has been observed that the storage stain on 55% Al-Zn alloy-coated sheet (Galvalume®) is seen as black corrosion products when water-damaged. Mild to moderate storage stain damage to Al surfaces is generally black in appearance (Al oxide), whereas it is white on Zn surfaces (Zn oxide). Galvalume coatings are largely composed of Al, whereas galvanize is largely zinc. The migration of Al to the surface of skin passed galvanized sheet to a level of at least twice that of non-temper rolled galvanize, could well be the reason for storage stain on the former product appearing dark. The dark appearance may also be related to the way light reflects off a water-damaged skin passed zinc surface, versus how it reflects off a water-damaged, as-coated zinc surface, which is seen as a white corrosion product. Dark zinc oxide is also seen on zinc surfaces damaged by fretting corrosion (see Section 4).

Whether edge staining is white or dark, both have the characteristic that the stains are a mirror image from the topside to the bottom side surface of the next lap in the coil.

***Prevention**: Galvanized coils must be prevented from being water damaged by condensation.*

More information – see http://www.galvinfo.com/galvinfonotes/

3.2 Protecting Galvanized Steel Sheet from Storage Stain

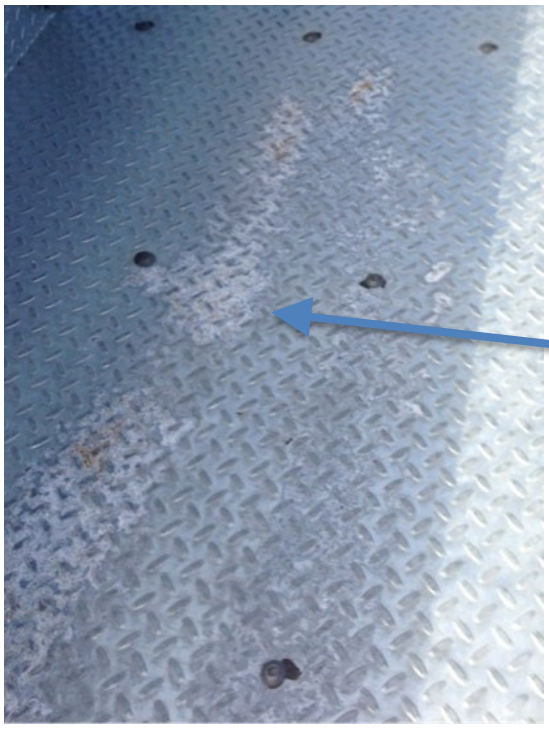
3.9 White Storage Stain resulting from Condensation

White rust on the edges of slit coils after a 3+ day truck shipment from Stockton, CA to Texas (October 2017)

Slit coils cut from passivated and oiled master coils in stock since 2014. The slit coils were shipped by truck from Stockton, CA to Texas, taking almost 4 days. How could white rust form on the edges? The likely cause was cooling of the steel, albeit unevenly, during its passage through the mountains. When it came in contact with warm and moist air after the mountains the temperature of the coils, or parts of them, could well have been below the ambient dew point, which would allow moisture to form on the coolest areas of the coil surfaces. The cut edges would have unpassivated zinc exposed, on which white rust can form very quickly. In addition to the coating thickness being exposed on both surfaces of each lap in the coils, some zinc does smear down the cut edge during slitting. The material in this case was successfully processed, as white rust did not have time to form on the flat sheet surfaces.

Prevention: *Be aware that moving cold steel into warmer air runs the risk of moisture condensing on the surface.*

3.10 White & Red Stain resulting from Improper Drainage



September 2013

The above two photos are of a spectator viewing stand constructed using G90 galvanized tread plate. The horizontal walking surfaces were designed to be canted for drainage, but parts of some were fastened too tightly to the supporting structure, creating dished areas that prevented

complete draining after wetting events. This interferes with the normal wet/dry cycle times, which prevents the formation of the protective film of $ZnCO_3$ needed to slow the atmospheric corrosion rate of zinc.

Prevention: *Products made from G90 galvanized sheet for outdoor use require that all surfaces exposed to the weather have good drainage and dry relatively quickly after rain events. Allowing water to pool changes the corrosion mechanism such that white ZnOH forms, which can rapidly consume the coating. A G90 coating (~20 microns [0.0008"] thick on each surface) can last 25 to 30 years in a rural environment exposed to normal wet/dry cycles.*

3.11 White Stain on Drums made from Galvanized Sheet

White stains on galvanized drums containing fruit juice (2020)

In South Africa, white stains appeared on galvanized drums containing fruit juice. Splotchy areas of white rust formed on the outside surfaces. The drums were made from Z100 galvanized sheet that was passivated. Double inner plastic bags were inserted inside the drums and then filled with fruit juice. The contents do not come in contact with the metal. After filling, the drums were

sent to a refrigerator at -18 ˚C before being sent to shipping containers, also kept at -18 ˚C. Some drums had to be defrosted at ambient temperature for some reason, after which the white stain appeared.

What most likely happened was that condensation formed on the cold areas of the drum surfaces Note that near the top of the drums there is no stain. That is probably because they were not filled right to the top and the steel temperature in those areas was not below the dew point – like the dry outside upper half of a half-filled glass of cold liquid outside on a hot summer's day. The drum in the first photo appears to have only been half filled.

Why did the passivation not prevent formation of white rust, and why is it so patchy? The process of forming the drums could likely unevenly disturb/remove the passivate from portions of the outside surface, which would allow condensate water (which is aggressive to zinc) to attack any exposed zinc.

Prevention: *The simplest solution is to not allow chilled, filled drums to be stored for any length of time in rooms that are above the dewpoint temperature of the drum contents. Another is to use drums with painted exteriors if the aesthetic look of the white stains is unacceptable.*

3.12 White Stain on Galvanized Sheet Roof

Uneven white rust formation on a G90 roof, 5.5 years old
– west-facing exposure, Spokane, WA area (2019)

White rust formed unevenly on the west-facing roof of a 5.5-year-old house in the state of Washington. The G90 sheet was laid over 7/16" OSB covered by a synthetic underlayment. The white areas formed slowly over time. The author has observed this type of white staining on a roof in Texas where the pure zinc sheet cladding had been laid directly on plywood. The white rust in the above photo is likely the result of dew-sourced water forming repeatedly on the surface when conditions allow, and then not being dried by the sun until later in the day because of its western orientation. One other factor is the variable heat transmission through the roof exemplified by the patterns formed on the surface. The white areas most likely fell repeatedly below the dew point and the dark areas did not.

The producers of zinc sheet for roofs provide design requirements for building using their products. One requirement necessary for the guarantee to be valid is an air gap of about 3/16" between the underside of the zinc sheet and the underlayment. This air gap is provided by means of plastic mesh. The air gap insulates the sheet from the building and is effective in preventing condensation.

***Prevention**: This problem is best solved at the design stage of building. Ensure that when roofs using galvanized sheet cladding are designed, use proven practices to minimize the chance for condensation to cause staining.*

Section 4: Fretting Corrosion

4.1 Fretting (Transit Abrasion) – Case 1

What first appears to be flaking at bends is actually black corrosion on the surface (August 2011)

A parts manufacturer received a batch that had been formed then stored for 6 months. The photo shows the surface marks present, which when examined closely, look remarkably like a form of fretting corrosion. This happens without moisture present. The marks are most likely due to the zinc surfaces rubbing together during handling and shipping over the 6 months.

Prevention: *In the case of parts made with galvanized sheet, they should not be allowed to touch each other under load if there will be frequent handling or shipment will be over long distances.*

More information – see http://www.galvinfo.com/galvinfonotes/

3.5 Fretting Corrosion (Transit Abrasion) on Galvanized Sheet, and

6.1 Successfully Shipping and Storing Galvanized Steel Sheet

4.2 Fretting (Transit Abrasion) – Case 2

Fretting corrosion (transit abrasion) on a coil of galvanized steel (2010)

In the case of coil form material shown above, fretting marks are located exclusively in the weight-bearing area of contact of the saddle support that cradled the coil(s). The coil had been shipped with its eye horizontal and aligned perpendicular to the direction of movement. *The fretting damage occurs under load and in the presence of repeated relative surface motion, as often induced by vibration.*

Prevention: *In the case of coils, 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.*

More information – see http://www.galvinfo.com/galvinfonotes/

3.5 Fretting Corrosion (Transit Abrasion) on Galvanized Sheet, and

6.1 Successfully Shipping and Storing Galvanized Steel Sheet

4.3 Fretting (Transit Abrasion) – Case 3

Fretting on Galvanized Poles (February 2012)

The above photos show fretting on galvanized poles in the center of their wide face. *An unsuccessful attempt to clean it is evident in the photo on the right. The black fretted areas most likely occurred during shipping of the poles in bundles with the wide faces in contact with each other.*

Prevention: *Depending on the distance over which such parts will be shipped, to protect against abrasion of zinc against zinc, would be wise to separate each layer of pole in a bundle with wood or plastic slats.*

More information – see http://www.galvinfo.com/galvinfonotes/

3.5 Fretting Corrosion (Transit Abrasion) on Galvanized Sheet, and

6.1 Successfully Shipping and Storing Galvanized Steel Sheet

Section 5: Galvanize Surface Staining Issues Related to Passivation

5.1 Darkening of Galvanize – Case 1

Darkened galvanize (right side) on grain handling equipment (2013)

Immediately after manufacture the above assembly was uniformly shiny. The material on the right side of the assembly darkened appreciably, compared to that on the left, during the first night outdoors. The galvanize use to make the bright area was mill passivated, while that used to for the dark area was oiled before shipping but *was not passivated*. As-coated galvanized sheet has aluminum present on the surface in the amount of 2-3 mg/m^2. When Al-Zn coatings such as Galvalume® show staining it has a dark appearance, so the Al on the surface of galvanize could be contributing the rapid darkening of unpassivated product. An effective passivate solution removes the surface aluminum on zinc coatings before depositing as a thin barrier layer on the surface. The significance of outdoor storage is that dew can condense on the surface of the metal. The darkening is influenced by the presence of atmospheric species such as sulfates, which can rapidly darken zinc in addition to any contribution from aluminum. Heavy mists and dew absorb sulfates much more than rainwater. The latter has a higher degree of mineralization

that can complex with sulfate ions, thus rendering it less aggressive than dew. Effective passivation forms a thin barrier over galvanize. which protects against rapid attack by dew water.

Prevention: *Be wary of using unpassivated galvanize for products that might be subjected to dew condensing on them.*

More information – see http://www.galvinfo.com/galvinfonotes/

6.3 Successfully Manufacturing Products made with Galvanized Steel Sheet

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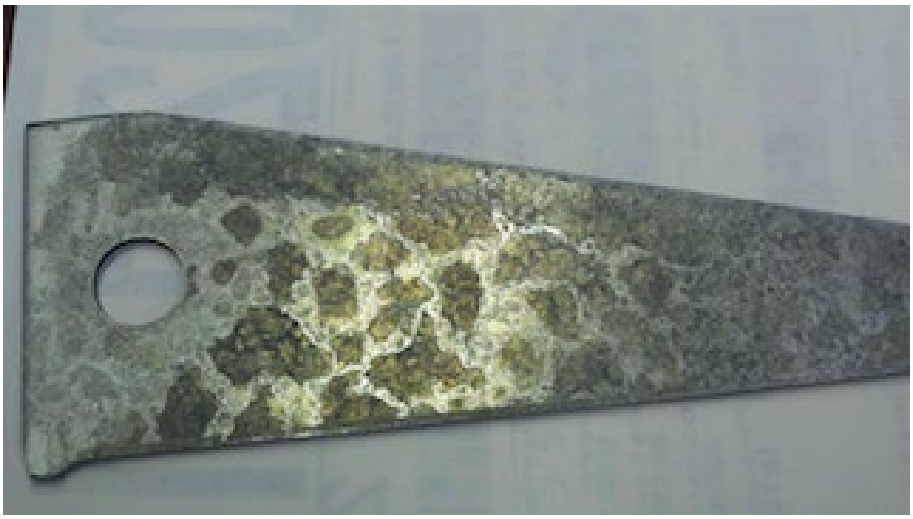
5.2 Darkening of Galvanize – Case 2



Extreme darkening on G90 (January 2012)

Unpassivated G90 galvanize that "rusted" in 3 days outdoors. The concern was that the product had a light coating. The condition was not rusting, but a fairly extreme example of darkening. The piece was in a scrap box outdoors. The less stained area at the left was covered by another piece and the other unstained areas could have been protected by press lubricant. Moisture from dew condensing on the surface can cause a dark, zinc oxide stain, sometimes overnight, if the surface is non, or inadequately passivated, as explained in Case 1. It is an appearance issue with very little zinc being consumed.

Prevention: *Unpassivated galvanize is subject to rapid superficial corrosion by condensate water. It should not be left in a location where dew can form on it.*

More information – see http://www.galvinfo.com/galvinfonotes/

6.3 Successfully Manufacturing Products made with Galvanized Steel Sheet

5.3 Darkening of Galvanize – Case 3

Uneven darkening of galvanized sheet panels on a large grain bin made with material from different lots (2019)

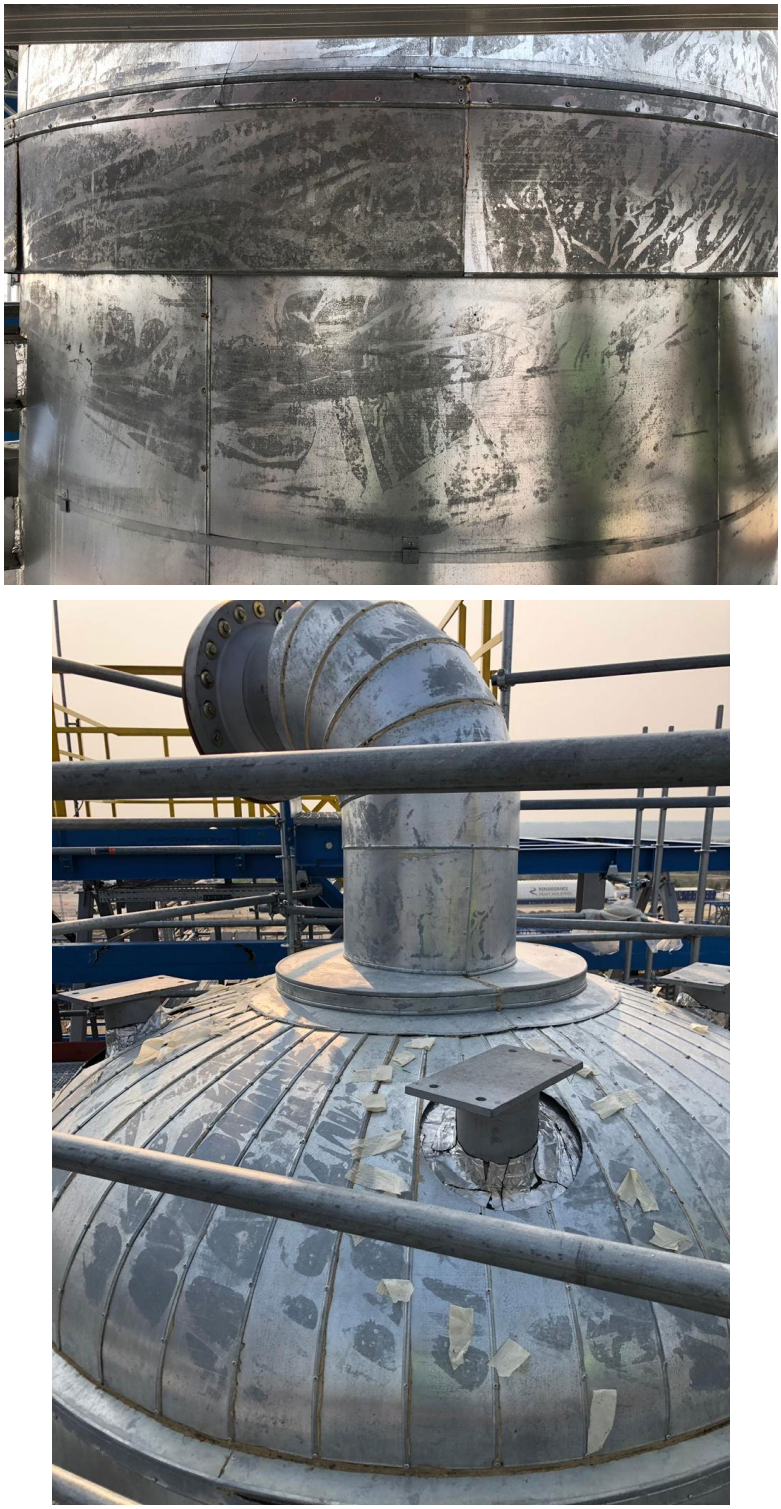
The sheet used to make this structure came from multiple lots of coils. Passivated material was used for all sheets, yet some remained bright for many months and others darkened literally overnight. The risk of using unpassivated galvanize was explained in Case 1 but that is not the case here as all material was passivated. What is possible is that the effectiveness of passivation may not have been uniform for all coating lots, depending on how well the passivation solution was controlled for concentration, pH, etc. A good passivation barrier can keep the weather away from the zinc long enough for slow oxidation to gradually and evenly dull it. An ineffective application of passivate can allow an increase in the rate the zinc is attacked as explained in Case 1.

***Prevention**: Users of galvanized products for appearance-sensitive end uses such as grain bins could work with producers to study the effect of mill passivation parameters on selective darkening to develop robust production practices to minimize its occurrence.*

More information – see http://www.galvinfo.com/galvinfonotes/

6.3 Successfully Manufacturing Products made with Galvanized Steel Sheet

5.4 Darkening of Galvanize – Case 4



Severe, sudden uneven darkening of galvanized sheet panels on a large refinery installation (2019)

Black stains formed overnight on galvanized sheet used to construct oil refinery equipment. The strange patterns on the surface could be related to patchy passivation film, due perhaps to starved squeegee rolls in the chemical treater on the coating line, or to abrasion of the passivation coating during forming and construction. The dark stains were not on the incoming material and nothing was visible for about 6 weeks after assembly started during a period of hot, dry weather. Then one morning, the stains were found throughout the equipment that had been installed during that period. Poorly or non- passivated galvanize can turn dark overnight if dew forms on it. Dew can contain sulphates as explained in the above cases. This incident happened at a refinery location, where sulphate content can be high in the air, and in any dew condensate that forms.

Prevention: *Users of galvanized products for appearance-sensitive end uses could work with producers to study the effect of mill passivation parameters on selective darkening to develop robust production practices to minimize its occurrence.*

More information – see http://www.galvinfo.com/galvinfonotes/
6.3 Successfully Manufacturing Products made with Galvanized Steel Sheet

5.5 White Foam on Framing Members

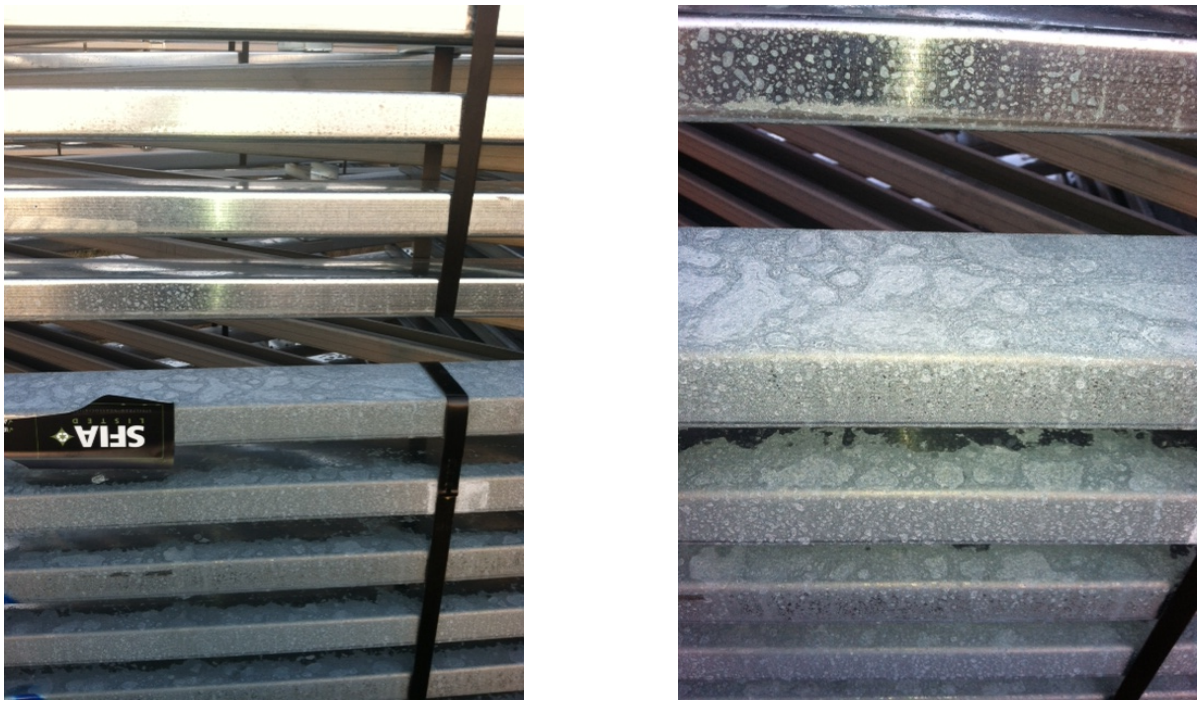
Unknown “foam” on framing after getting wet in the field (January 2008)

A mysterious “foam” formed on G60 trusses after a rainfall. It only happened on one batch. Various inquiries did not come up with a root cause, although the most likely was thought to be an improperly cured acrylic passivating treatment.

***Prevention**: producers of acrylic coated galvanize should be certain that the acrylic is fully cured off the galvanize line to ensure that it does not liquefy if it get wet in the field.*

More information – see http://www.galvinfo.com/galvinfonotes/
2.10 Imparting Resistance to Storage Stain, and
3.2 Protecting Galvanized Steel Sheet from Storage Stain

5.6 White Stain on Framing Members



White staining on stacked framing members (December 2013)

Framing members were produced, stacked (in a very favourable way) and stored outside, as is the company's usual practice. After a rain, the bundles were stained (shown above) after a day or two. The producer normally stores formed framing outside with no issues, as should be the case with passivated material stacked in such an open, and stain-resistant configuration. From the photos it appears that only the lower members are stained, and they turned entirely white. There were different lots of material involved. Apparently, some Cr^{+3} passivates can be prone to this problem, perhaps if not cured properly or by reacting with roll forming lubricants.

***Prevention**: Chromium^{+3} passivates need to be fully cured to be resistant to softening leading to staining problems.*

More information – see http://www.galvinfo.com/galvinfonotes/

2.10 Imparting Resistance to Storage Stain, and

3.2 Protecting Galvanized Steel Sheet from Storage Stain