Next Generation Metallic Coatings

As the alloy layer is inhibited on continuous galvanized coatings, the coating thickness is independent of dipping time, steel gauge and chemistry. Surface roughness can have an effect however is only relevant if the process includes some form of abrasive cleaning; in almost all cases coating thickness is controlled by gas wiping of the molten zinc. Continuous galvanizers are able to vary and control the coating thickness much better than in batch galvanizing, however, are still limited in the amount of zinc that they can apply. This has driven the development of heat-dip zinc-aluminium based coatings which offer improved corrosion resistance over traditional galvanized zinc coatings of similar coating thicknesses. Unlike galvanized coatings, heat-dip zinc-aluminium coatings do not exhibit a linear corrosion rate. For example the weight loss of Galvan (Zn-5Al) during the first two or three years is slightly less than a galvanized coating, but as its surface passivates its rate of weight loss decreases parabolically. Over a long term exposure period, Galvan typically provides 2 to 4 times the durability of galvanized coatings of the same thickness\(^1\) (Figure 3).

In general, zinc-coated (Type Z) steel is intended for applications requiring low to moderate corrosion resistance.

Zinc-aluminium-coated (Type ZA) steel is used mostly for applications that require good coating ductility and in environments requiring moderate to high corrosion resistance with good galvanic protection. Zinc-aluminium has the best formability of all the coating classes and its corrosion resistance is much better than zinc, but less than unformed ZM coatings. ZA coatings retain a higher degree of corrosion resistance after forming than coatings with brittle alloy layers.

Zinc/aluminium/magnesium-coated (Type ZM) steel has high to very high corrosion resistance in many aggressive environments with good galvanic protection.

Aluminium/zinc alloy coatings (Type AZ) offer excellent barrier-coating protection combined with some galvanic protection and very high corrosion resistance on unformed panels. Aluminium/zinc/magnesium alloy coatings (Type AM) are being offered as a more corrosion resistant alternative to AZ coatings and give excellent barrier-coating protection combined with better galvanic protection than AZ. The corrosion resistance of these coatings is very high in most environments, however, these coatings give less galvanic protection than Zn based alloys, and are therefore less suitable for thicker gauges. Aluminium alloy coatings also have poorer alkali resistance compared to zinc alloy coatings, although AM is better than AZ, so are not suited for applications involving intensive animal farming or contact with concrete.

It is difficult to specify the absolute relative performance of each of the above coating types as performance varies with end use and exposure environment, however, for all coating types, coating life is a function of coating thickness.

The key benefit of using high performance metallic coatings is increased service life over traditional galvanized coatings, particularly in unwashed and marine applications. Typically, improved product durability can be achieved at lower coating thicknesses than traditional zinc coatings. Some coating classes offer additional benefits, such as improved formability or paintability, so selection of the appropriate coating for a given application should be made based on a range of considerations including the application, the environment and the durability requirement.

For heavier gauge products such as roll-formed structural sections, formability of the coating is an important consideration. Roll forming may have no effect whatsoever on the coating, however the likelihood of damage increases with increasing substrate gauge and decreasing bend radius and can be influenced by steel grade. Cracking through the coating provides initiation points for corrosion with a corresponding decrease in service life (see figures 4 and 5); in extreme cases debonding of the coating may occur.
coating decreases its formability and cracking resistance (due to formation of a hard & brittle MgZn phase) so the effect of cold forming heavy gauge product would require careful evaluation before being deemed suitable for this particular application.

In summary, the trend in metallic coating development is for thinner, more corrosion resistant alloys with zinc/aluminium/magnesium alloys replacing zinc, and aluminium/zinc/magnesium replacing aluminium-zinc. For applications requiring maximum ductility, zinc-aluminium is the best choice with a corrosion resistance between zinc and zinc/aluminium/magnesium. All zinc alloy coatings require passivation and the common trend among all coating classes is the phasing out of hexavalent chromium-based treatments in favour of less hazardous alternatives.

References

[1] Pad wiping and magnetic wiping are used in continuous wire and rod galvanizing lines as an alternative to gas wiping.


[3] Hot-dip 5%Al-Zn (Galfan) coated and pre-painted 5%Al-Zn(ColorFan) coated steel products, Yieh Phui Enterprise’s Product Brochure (data courtesy of the Galfan Development Organisation).


[5] David HARRISON and Yihui LIU, Corrosion Resistance of Continuous Hot-dip Zn-12Al Coatings, 8th International Conference on Zinc and Zinc Alloy Coated Steel Sheet (Galvatech), Genova, Italy (2011).

[6] Lintels are subject to the durability requirements of AS/NZS 2699.3:2002, Built-in components for masonry and shelf angles. AS/NZS 2699.3 classifies durability using an R rating, which is based on airborne salt deposition rates.


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