HOT-DIP GALVANIZATION OF STRUCTURAL STEEL:
PROCESSES, TYPES OF COATINGS AND STANDARDS

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SUMMARY

Galvanization provides a corrosion-resistant coating to structural elements. Five zinc-based coating methods are available according to your needs and the type of steel being used. However, certain rules and standards must be respected.

HOT-DIP GALVANIZATION OF STRUCTURAL STEEL

The hot-dip galvanization (HDG) of structural steel has been used successfully in North America for over 150 years, ensuring the availability of steel components that feature excellent protection against corrosion.

Galvanization process

HDG, which is applied under controlled plant conditions, establishes a metallurgical bond between molten zinc and steel. This bond ensures molecular adherence and cathodic protection resulting in superior corrosion resistance. The process is not overally complex but each step is crucial in order to achieve optimal results (figure 1).

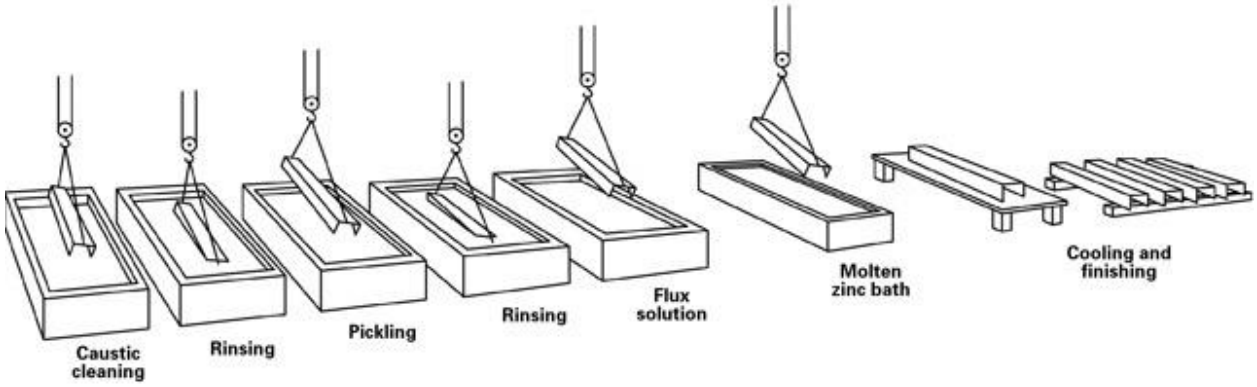

Figure 1
Hot-dip galvanization process

When the prepared steel is immersed in a bath of molten zinc at a temperature of 450 ºC (840 ºF), the zinc bonds metallurgically to the steel, subsequently successive layers of a zinc-iron alloy of varying percentages are formed in addition to a final layer of pure zinc (figure 2).

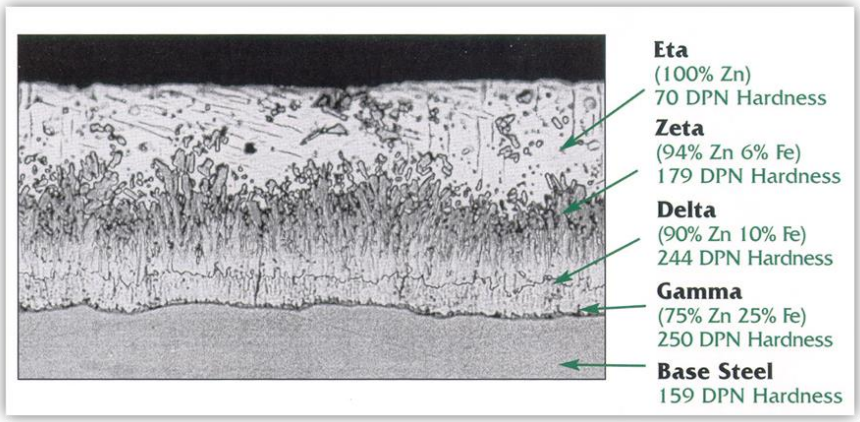

Figure 2
Microphotograph of a galvanized coating

Features and types of zinc-based coatings
In addition to forming a physical barrier against rust, the zinc coating also offers cathodic protection to exposed steel. A wide range of steel products feature the corrosion resistance properties provided by galvanization, from nails to steel structures including bridges.

Five types of zinc-based coatings can be provided to obtain corrosion resistance as follows: metallization, hot-dip galvanization, zinc-based paint, galvanized sheeting and zinc plating (figure 3). These coatings differ in terms of the thickness of the zinc alloy, application methods and the duration of corrosion resistance.

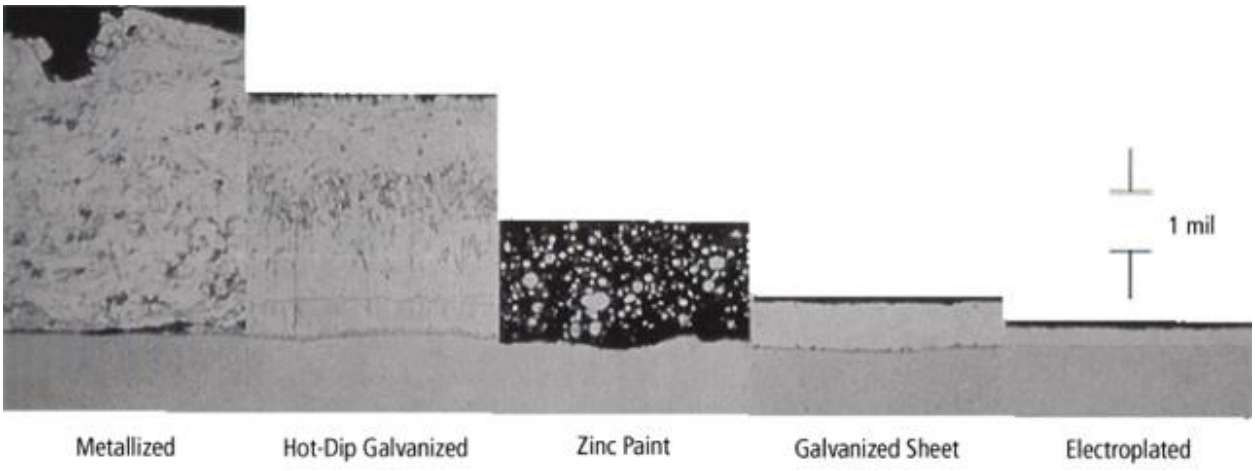

Figure 3
Types of zinc finishes

Important considerations about galvanization
Although galvanization is an excellent choice to protect steel, several elements must be taken into consideration prior to initiating the process, as follows:

A) Size of kettles
The capacity of the galvanization kettles must be assessed beforehand to ensure that components can be completely submerged in the zinc solutions. In cases where components are too large for total immersion, it may be necessary to dip them progressively, which is sometimes referred to as double-dipping. However, this process will produce a visible indentation where the two dips overlap.

B) Steel sélection
(Reference Standard ASTM A385)
Steel materials must be chosen carefully to ensure optimal corrosion resistance. Generally speaking, galvanized coatings are selected for their anti-corrosive properties and not for their appearance. The relative corrosion resistance is independent of the overall appearance of the coating.

The quantity of the four following elements found in steel are known to negatively impact the galvanized coating:

- Carbon: in excess of 0.25%
- Silicon: between 0.04% and 0.15% or above 0.22%
- Phosphorus: in excess of 0.04%
- Manganese: in excess of 1.3%

C) Good design practices
Vents and drainage holes allowing for the free circulation of air, surface preparation fluids and zinc in all cavities and surfaces are all necessary to ensure the thorough coverage of components since galvanization is designed to provide integral protection, the zinc must be free to travel across all areas of the steel component.

D) Compliance with recommendations
Sealed welds are highly recommended in order to prevent the bleeding of surface preparation solutions that could compromise galvanization coverage. Sealed welds improve the galvanization process in areas considered at risk.

A minimum SSPC-SP7 brush-off blast cleaning of the steel is also recommended prior to galvanization. This serves to clean the steel and welds thoroughly in addition to producing a light surface profile for the zinc to adhere to.

Galvanization standards

Standard CAN/CSA G164-M92 is currently utilized in Canada for the galvanization of structural steel components while ASTM A 123/A 123M is the United States Standard. The following table presents a comprehensive listing of the standards applicable to hot-dip galvanized materials.

A 123/A 123M-02	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A143/A 143M-03	Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
A 153/A 153M-03	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 384/A 384M-02	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
A 385-03	Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
A 767/A 767M-00b	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A 780-01	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
B 6-0	Specifications for Zinc
D 6386-99	Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Products and Hardware Surfaces for Painting
E 376-03	Standard Practice for Measuring Coating Thickness by Magnetic Field or Eddy-Current Exam Method
CAN/CSA G164-M92	Hot Dip Galvanizing of Irregularly Shaped Articles

CONCLUSION

The hot-dip galvanization of structural steel should be considered in projects featuring exposed components that require long-term protection against the elements. HDG also provides the added benefit of clean and low maintenance finish.

REFERENCES

- Corbec, a Quebec leader in the field of galvanization for over 40 years.
- Galvazinc, a French association for the development of HDG in Europe.
- American Galvanizers Association (AGA), a U.S.-based trade association that provides information and technical support in the area of galvanization.

Should you require additional information, wish to meet with one of our representatives or experts to learn more about our products and services or to organize a lunch and learn, please call:
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