Galvanize the Future: A Richard L. Brooks Memorial Scholarship

Hannah Power

University of Delaware

Use of Architectural Exposed Structural Steel (AESS) With Hot-Dip Galvanized (HDG) Components for Building Façades

POWER
ENGINEERING

Thank you for the opportunity to apply for the AGA Galvanize the Future Scholarship. The following report is for the fictional Miss Ingenium, a building owner, who is a client of Power Engineering. Miss Ingenium wants her building to have a façade with architectural exposed structural steel (AESS) with hot-dip galvanized components but has heard galvanizing can have mixed appearances. Power Engineering will make a case in the following report for hot-dip galvanizing to be used for Miss Ingenium's building façade.

Dear Miss Ingenium,

Thank you for expressing interest in using our company, Power Engineering, to design, create and erect a beautiful and functional façade for your building. We specialize in the use of architectural exposed structural steel (AESS) for building façades and use hot-dip galvanized (HDG) components for a maintenance free, structurally sound and corrosion resistant product. I understand the concerns regarding the varying appearance of hot-dip galvanized components, but I can assure you that we have a number of practices that help to make our façades uniform and attractive that follow the AESS requirements. I have first outlined a number of benefits that an AESS with HDG components façade will provide your building and all of the practices we use to create a uniform product to assure that you are satisfied with the appearance of our product.

Sincerely,

Hannah Power

POWER
ENGINEERING

Benefits of Architectural Exposed Structural Steel and Hot-Dip Galvanization:

Design Flexibility

There are many attractive façades that we at Power Engineering will be able to create for your project using AESS with HDG. Our product has an extremely high strength to weight ratio meaning that our façades will add minimal dead load to your building and not affect the design of the structure. Using AESS, the façade designs we can create are endless because it is easily molded and transformed to fit any style and application. Since all AESS with HDG façades are produced in a factory and brought to site ready to erect, construction times are fast, and the façade can be built in any weather. All these elements of design flexibility allow for less material and time to be used, making the use of AESS a great cost saver. Hot-dip galvanizing will also eliminate maintenance costs throughout the life of the façade which is discussed in a following section.

Maintenance

HDG coatings on AESS can withstand both corrosion and handling that cause damage to other materials. When the AESS is dipped during galvanizing, zinc bonds to the surface of the steel which undergoes a chemical reaction that creates a coating that is harder and tougher than original AESS. This HDG coating will allow your façade to endure for decades without maintenance. Figure 1 depicts how the thickness of the zinc coating directly affects the amount of time until the first maintenance.

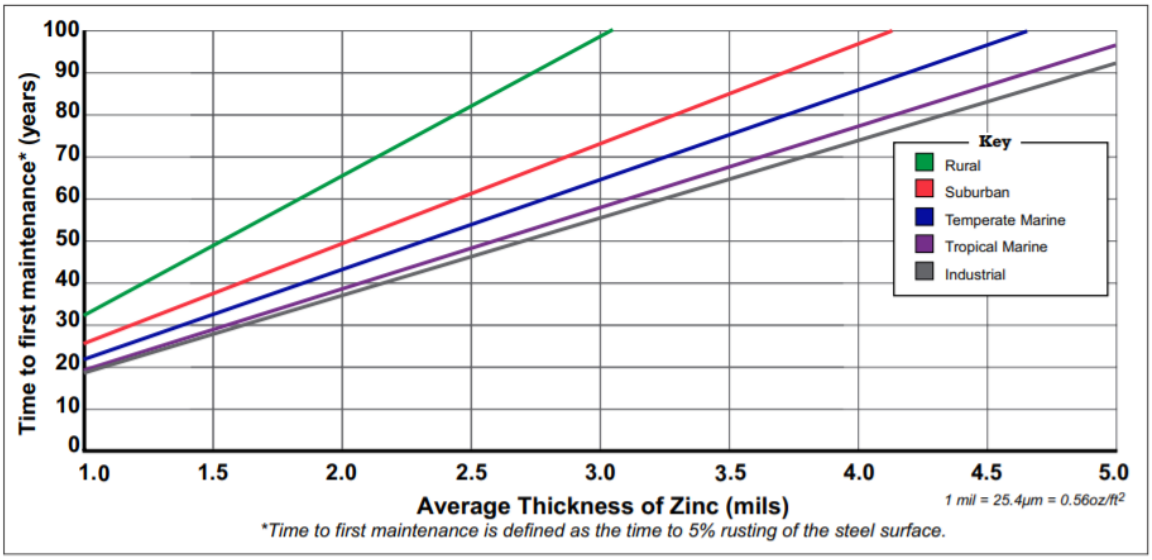

Figure 1: Time to First Maintenance (American Galvanizers Association, 2016)

Hot-dip galvanizing your building façade will certainly save money throughout the life of the building and it is likely that the design life of the building will be shorter than the time to first maintenance of the façade. I have taken the liberty of using a life cycle cost calculator that was developed by The American Galvanizers Association and determined that the total life savings that this building can expect to see if you choose to use HDG on your façade is approximately 92%.

Durability, Corrosion Protection, & Life Span

An AESS building façade with HDG components will add a great deal of protection to your building. The galvanization of the steel acts as an environmental protectant, and it will not succumb to rust like other metals exposed to water, wind, salt, etcetera would. HDG steel benefits from both physical and chemical protection. The zinc coating on HDG materials acts similarly to paint on traditional steel protecting it from the elements, but it also has chemical cathodic protection. The HDG components have corrosion protection embedded into them, rather than just painted on top, and they can withstand significantly more intense and long-lasting environmental hazards. This contributes to the low maintenance discussed earlier, but it will also help to protect the structural members in your building, allowing for a longer life span of not only your building façade, but your structure as a whole. Figure 2 depicts a steel façade that was not hot-dip galvanized and has corroded as well as a building that utilized hot-dip galvanization and is not corroded.

Figure 2: (Left) Corroded Steel Façade in Long Island City, Queens, NY and (Right) Pyramid Residential Building in New York, NY with HDG Façade

Sustainability

I know you are interested in keeping your building as green as possible, Miss Ingenium and we can assure you that hot-dip galvanized AESS materials are some of the most recyclable and renewable construction materials on the market. HDG utilizes zinc, the 27th most abundant material in the Earth's crust and iron which can be completely recycled without losing any properties, meaning that all of our HDG products can be reused and renewed. The HDG coating will likely outlast the life span of your building, eliminating the need to ever replace or fix it which would use additional energy and resources. Hot-dip galvanized AESS is a beautiful product that will never need to be painted, allowing for less environmental harm as many paints used in steel construction today release volatile organic compounds. To assure you that your building façade not only bodes the benefits above, but also maintains a uniform and beautiful appearance, there are a number of steps we plan to take that are outlined in the following section.

Unifying the appearance of Hot-Dip Galvanized Steel

Hot-dip galvanized steel may have a variety of appearances right after production, but once it is exposed to the environment for approximately 6 months to 2 years, all HDG products weather and have a matte gray finish. Miss Ingenium, I can assure you that the appearance of HDG does not affect its ability to be a functional façade for your building, but we have a number of practices outlined below that we will use to create a uniform façade from the day it is produced. You can expect that no matter the appearance of the façade that we install, the AESS HDG will be matte gray and uniform within a few years. Our processes meet all AESS requirements and are safe and effective ways to alter the look of your façade while keeping its structural properties.

Spangle

A spangled appearance of HDG steel is the result of some zinc crystals on the surface of the material being more prominent. To avoid spangle, we will immediately quench all components of your building façade as they are withdrawn from the galvanization bath as this will cool the material to a point below where the crystals that cause the spangled appearance can occur. Immediately quenching will also help to prevent the material from have a mottled look.

Shiny/Matte Coating

The initial appearance of the façade can be either shiny or matte, but as your building is exposed to weather, the hot-dip galvanized AESS will become matte. To achieve an initially shiny coat, we plan to use an AESS that is within the limitations of ASTM A385/A385M as steel that falls here has a chemical makeup that assists the growth of the zinc layer on the material, which in turn makes the surface appear shiny. Other steps that we can take to achieve a shiny coat include increasing the withdraw rate of the façade elements from the kettle and quenching the material very quickly after it has been galvanized. If you would prefer that your façade is installed matte as that is what the final appearance will be, we can treat the façade in the factory after it has been produced just as the shiny material would be. The other option is to use a more reactive steel which is not within the limits provided in ASTM A385/A385M as the surface of the AESS will need to be more reactive to initially form a matte coating.

Varying Appearance

A single piece of HDG AESS can have multiple areas with different looks. The reasoning for this can be due to connecting sections of AESS with varying thicknesses, welding pieces together and using different types of steel. To assure that we have uniformity across each part of your façade, we will use a single grade of AESS that falls into the requirements. In areas where welding is required, we will avoid a varying look by using a welding rod that has the same silicon content as the AESS. Your façade will consist of a single grade and a single thickness of HDG steel to assure the best appearance.

Lines from Overlapping Coating and Oxidization

When larger pieces of AESS are hot-dip galvanized, it is possible that they may not entirely fit into the galvanizing kettle. This can cause thicker areas of zinc coating on the material which appear darker, and the material can have a stripped appearance. To avoid this on your building façade, we plan to use smaller element that will fit into our kettles. If there are pieces that have overlapping coating, we can buff and/or grid that area so that the coating is more even. Another reason why lines could form on HDG AESS pieces is due to oxidization. This happens when elements are taken out of the galvanizing kettle at a varying rate. To make sure to avoid oxidation lines on your façade, we will use pieces that are smaller and easier to handle so that their withdraw speed is constant as well as ensuring that there are lift points on each piece of the façade so it can be easily removed from the kettle.

Storage and Touch Up

After your architectural exposed structural steel HDG façade has been produced, we will store it in a cool, dry, and well-ventilated area so that no staining occurs after production. We have metalizing and weathered color zinc paint that can be used to touch up any small areas of imperfection to make each piece of the façade uniform before it is installed.

When we erect your new building façade it will be functional, beautiful and be ready to stand for the next century. I can assure you that there are many benefits to using AESS that you cannot obtain from any other material. It will be durable and resistant to corrosion, lasting longer than any other façade you could choose. The maintenance will be minimal and will not begin for nearly one hundred years after we install the façade. You will be able to choose any shapes and appearances for your building as AESS is very versatile and its high strength to weight ratio will not impact the loads on your building. The materials we use are highly renewable, making your green initiative achievable.

I understand the concerns regarding a possibly irregular appearance of the façade, but we at Power Engineering will take all necessary steps to create a uniform product. Through proper use of quenching, the galvanizing kettle and AESS that meets the requirements outlined in ASTM A385/A385M, we will produce a consistently beautiful façade. We care for your product during and after the galvanizing product and can guarantee you that when we put your façade on your building your satisfaction will be great.

Resources:

"AESS: Challenges and Opportunities for the Galvanizer." American Galvanizers Association, 2 Aug. 2018, galvanizeit.org/knowledgebase/article/aess-challenges-and-opportunities-for-the-galvanizer.

"AISC Section 05 12 13 – Architectually Exposed Structureal Steel." American Insitute of Steel Construction, 2017, www.aisc.org.

"Building & Architecture". American Galvanizers Association, 2017, galvanizeit.org/hdg-in-use/building-and-architecture.

"Constructing a Facade Both Rugged and Rusty (Published 2012)." The New York Times, 2021, www.nytimes.com/2012/08/28/nyregion/building-with-weathering-steel-both-rugged-and-rusty.html.

"Hot-Dip Galvanized Buildings and Architecture. "American Galvanizers Association, 2016, https://galvanizeit.org/uploads/publications/Galvanized_Buildings_and_Architecture.pdf

"Life-Cycle Cost Calculator." American Galvanizers Association, 2021, lccc.galvanizeit.org/report/42bdb92d378f2d60197adfae8adf8835.

"What is Cathodic Protection?." American Galvanizers Association, 25 Nov. 2013, galvanizeit.org/knowledgebase/article/what-is-cathodic-protection.