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1. One of the biggest market limitations to the specification of hot-dip galvanized steel is lack of knowledge. What do you believe are the three biggest benefits of hot-dip galvanizing, and how would you educate the specification community to promote its use? (Provide specific information on why these benefits will increase the specification and what delivery method you would use to promote.)

(All of the following information used and described in this scholarship entry was obtained from the AGA website, galvaniteit.org.)

Hot-dip galvanizing (HDG) has been around for over 150 years, improving the corrosion resistance of steel in harsh environments. As the world pushes for more sustainable and versatile materials, specifications should incorporate HDG more often. All of the science available behind HDG proves it has great corrosion resistance and specifications are becoming more open to HDG, as this inherent quality leads to greater product longevity. To promote the push for HDG among the specification community, focus should be given to the three main benefits of HDG: reliability, sustainability, and versatility. If knowledge of the biggest benefits of HDG were more widely spread, the result would be a larger market for HDG leading to a more pronounced presence of HDG products around us.

The inherent qualities of both anti-corrosion and reliability of HDG products are shown where many HDG products have existed for decades. One of the golden examples of HDG reliability is the Brooklyn Bridge. Over 14,500 miles of HDG wire was used for its cables, and a century later when the bridge was repaired, the wires were in great condition. Regardless of the application, HDG products immediately reap the benefits of dependable protection. This protection is three-fold. The first layer is a metallurgically bonded zinc coating, acting as a seal to the corrosive environment the steel is exposed to. Additionally, zinc provides cathodic protection, since the anodic zinc will preferentially corrode to protect the less noble steel even if mechanical damage were to expose the underlying steel to a corrosive medium. Finally, there is a top-coat of zinc patina, a layer that forms naturally from the weathering of the surface and begins with zinc-oxide formation. This layer can take anywhere from six to twelve months to fully develop, depending on environmental conditions. Thus, HDG products are clearly able to coexist with nature, because with the addition of the bottom two layers, the top layer of natural zinc patina forms in response to varying weather conditions for further product

protection. Although specifications may only consider one coating, HDG gives reliability through the complete and uniform three-fold protection, even around corners and edges. Since HDG is a total-immersion process, the protective layers grow perpendicularly from all directions.

Due to the rising upfront and maintenance costs of many existing anti-corrosion coatings, specifications greatly weigh in on life-cycle costs during material selection. One way to increase support for HDG reliability among the specification community is to practice the ASTM A1068 in conjunction with AGA's service life chart rather than each method separately. Together they make a stronger case for HDG promotion than if used individually, showing HDG products are two to six times more economical and reliable compared to other coatings in most environments. According to ASTM A1068, there is a Life-Cycle Cost (LCC) analysis that provides quantifiable prediction of a corrosion protection's reliability. LCC analysis begins before production and aims to justify higher up-front fees for a coating with lower life cycle costs over an initially less expensive coating with higher maintenance costs. With the American Galvanizer's Association's (AGA) service life chart, it is possible to predict how long HDG steel may last under different soil conditions. There are over thirty coatings to choose from for a given application on the AGA service life chart, enabling the specification community to certify the most durable coating for minimum cost. Using the LCC analysis under ASTM A1068 and the AGA's service life chart together in the specification community would advocate HDG use.

In addition to its reliability and corrosion protection, HDG should be recognized for its sustainability. Specifications are becoming more particular about chosen materials, as they are receiving greater social pressure to select materials that enforce high environmental standards. According to AGA's online resources, sustainable development is "the social, economic, and environmental commitment to growth and developments that meets the needs of the present without compromising the ability of future generations to meet their own needs." HDG gives specifications the opportunity to use steel sustainably. Not only can zinc from the HDG coating last decades and even a century, it is also on par with the abundance and recyclability of steel. Both steel and zinc are 100% recyclable and very abundant in the earth's crust. They can also be infinitely recycled

without losing material integrity, enhancing sustainability by allowing future generations to reuse any existing HDG steel.

The specification community could promote HDG use if it could better understand all of the sustainability benefits of HDG. This can be achieved by creating a HDG sustainability chart, much like those for water or nitrogen cycles. First, the chart could depict a general EAF steel-making process, which uses recycled zinc coated and scrap steels to produce steel. Here, it should be noted that the volatile zinc is recovered from the zinc products and can be used in the subsequent HDG process. Next, it could show products of HDG steel in service and mention the longevity of the product before maintenance is required, showing HDG is reliable and can survive in an array of environments for long periods of time. Finally the chart could demonstrate the zinc coating interacting with the environment before the product is recycled when new steel is needed. For this portion of the chart, it should highlight that zinc does not pose a threat when in contact with humans; in fact, mammals need certain daily and trace amounts of zinc to function properly. We are already exposed to zinc in its oxide form in many products, including sunscreens, baby powder, and cosmetics among others.

While North America strives for sustainable development, it also pushes for versatility, where a versatile product can be reliable, aesthetic, and economical in many environments. HDG products come in many shapes and sizes because of its total immersion process that offers full, uniform protection. These products include structural steel and plate, wires, pipes, fasteners, and tubing. Furthermore, any combination of these individual products can be combined and then undergo HDG as one piece. Required specifications that apply ASTM A123/A123M standards cover all of these versatile HDG products, including their coating thickness, finish, appearance, and adherence. For hardware products such as fasteners, the ASTM A153/A153M delineates all requirements for the products to be within specification. Zinc tends to react in concrete environments, but because it is such a large market, there are ASTM A767/A767M standards available to ensure durability of HDG “rebar,” or reinforcing steel bars in concrete, which include an additional chromating step to prevent reaction between the zinc coating and the concrete.

Increased awareness of the specification community about the versatility of the size and wide range of environments that HDG products are used in should be reinforced. This can be done by educational field trips to show the final HDG product and the ASTM specification linked to it. Since members of the specification community may lack this knowledge, it is often best to show how the knowledge is extended into real world applications. Communities in regions of high seismic activity may choose to showcase HDG versatility advantages through visiting their client's neighboring structures like buildings. These structures rely on the tensile strength and elements of HDG steel to remain standing after any inertia effects due to earthquakes. Communities in other regions may choose to visit neighboring structures like bridges, which rely on chromated and HDG rebar to remain maintenance-free for decades. Wherever the location, this is an effective way of exhibiting the versatility of HDG while increasing its promotion in specifications.

Steel itself provides constructors and engineers the freedom to apply a versatile material and HDG provides the material the freedom to endure almost any environment. Without HDG, traditional steel would not be able to survive for as long and would need to be replaced more often. If this knowledge were more widely spread among members of the specification community through LCC and service chart reliability tutorials, HDG sustainability and life cycle charts, and informative versatility field trips, there would be a larger HDG market and a greater presence of these durable products. HDG is rightfully pushing to be included in a world that is continually striving for more reliable, sustainable, and versatile materials. HDG has existed as a reliable corrosion-resistant steel process for over a century, and it is only a matter of time before its presence grows.