The American Galvanizers Associations (AGA) *Galvanize the Future: A Richard L. Brooks Memorial Scholarship* essay contest

Ze Yao (LeiLei) Zhao

Honours Bachelor of Architectural Studies

University of Waterloo, School of Architecture

Essay Question 1:

Every four years, the American Society of Civil Engineers' Report Card for America's Infrastructure depicts the condition and performance of American infrastructure in the familiar form of a school report card—assigning letter grades based on the physical condition and needed investments for improvement. In 2021 ASCE conducted this study and gave the nation's infrastructure a "C-" grade. Review ASCE's dedicated Report Card for America's Infrastructure website and find infrastructure project(s) in the AGA's Project Gallery that are in your local area. Visit the project(s) site to visually inspect the project, take photos, and write a report on its overall condition, its impact on the local community and how hot-dip galvanized steel will protect the project from corrosion over its life. Explain how specifying more hot-dip galvanizing to protect steel from corrosion will ultimately increase ASCE's infrastructure grade in future reports. Discuss how additional funding from a new government Infrastructure Bill could be used to galvanize more steel that will help protect our nation's infrastructure for generations to come.

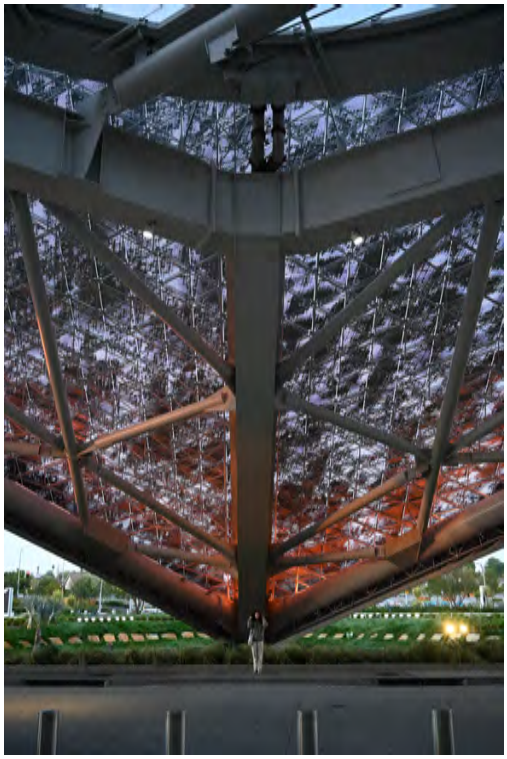
Local project from the AGA's Project Gallery:

The SoFi Stadium in the Los Angeles County, California, USA

1001 Stadium Dr, Inglewood, CA 90301

Construction: 2016 - 2020

Self-taken Project Images



Costing $5.5 billion, the SoFi Stadium is the most expensive venue ever built, and when I visited it became evident why. The stadium is in pristine condition, appearing as if it had just been constructed despite being completed less than two years ago. The unique, open-air stadium design features a complex and captivating structural steel system; 600 tons of the total 70,000 tons of steel are hot-dip galvanized (HDG) and form the superstructure that wraps the stadium. The structure is extraordinary when viewed at all scales: from a distance where it can be admired in full view, up-close where its incredible size can be fathomed, and zoomed in where the intricate structural details can be appreciated. As expected from a Duplex System of this age, the infrastructure is in excellent condition and shows no sign of age, wear, or corrosion. Meanwhile, the additional layer of white powder coating on top of the galvanization has clearly been effective in its protective functions and maintaining a clean appearance, while further serving its aesthetic purposes in expressing the sleek design of the space.

This well-preserved pristine condition plays a significant role in the cultural impact of the project. In the short time since its completion, the SoFi Stadium has made a landmark impact at every scale, from the County of Los Angeles and the Southern California Region, to the larger national level, and soon an international level as well. The stadium currently serves the local community with an art exhibition and has had a transformative impact on the City of Inglewood. However, where it displays its impact to its fullest capacities is in reinvigorating Los Angeles as a landmark building for hosting sports and entertainment events. With each event, up to 100,000 people (the expanded maximum capacity) from this extended community are united under a single roof to cheer and celebrate. This was epitomized with the recent Super Bowl in 2022 where the building performed incredibly and united America over one of its most popular sports. As the 2028 Olympic games approach, the SoFi stadium is set to host the opening and closing ceremonies, which will undoubtedly further elevate the building's impact to an international level.

With the SoFi stadium's far-reaching impact serving as Los Angeles' landmark venue, it is crucial that the building can remain pristine for as long as possible. The structure's extensive use of steel fully exploits its material capacities, allowing for such an ambitious design and construction. However, with these benefits comes unique challenges that arise from how steel interacts with its environment, especially its susceptibility to corrosion. It is an inevitable process caused by exposure to water, oxygen and other chemicals that lead to significant structural and aesthetic complications. The SoFi stadium's cultural significance and the Los Angeles climate call for a substantial level of corrosion protection, as it is in both an Industrial and Marine climate containing higher levels of chemicals, pollution and moisture in the atmosphere. As opposed to steel, zinc corrodes at a significantly slower rate; the HDG process utilizes this by chemically bonding zinc to a steel surface to create a tightly-bonded alloy coating, providing significant corrosion protection for the steel. This coating protects on three different fronts: the impervious coating physically prevents the steel from interacting with the atmosphere and thus from corrosion; the zinc provides sacrificial protection for the steel even as breaks in the coating develop; and most importantly, as the zinc does corrode, it forms a film of patina that provides a strong level of protection to the alloy coating itself. These processes are unique to the HDG protection system and distinguish it from other methods that do not provide as durable a protection from corrosion, effectively protecting the SoFi Stadium from corrosion.

The HDG method excels not only in its protection from corrosion, but more importantly its ability to do so over a project's entire lifetime. Ultimately, the longevity of a corrosion protection system comes down to maintenance, and in non-HDG systems this can become prohibitive. This is demonstrated clearly in the Life-Cycle Cost Calculator in Figure 2, where a project like SoFi will see a 90% Life-Cycle Cost Savings for its choice of using HDG over a more common Polyurethane paint system. Despite the higher Initial Cost of an HDG system, this is easily repaid over the stadium's Life-Cycle Cost Savings. Unfortunately, systems with a cheaper Initial Cost are often preferred, and these short-sighted savings always result in consequences in the long run, either financially or in corrosion. The HDG system is not susceptible to such uncertainties, as the initial investment is paid off well over a structure's lifetime. Not to mention the Duplex system that includes an additional powder coating on top of the HDG steel, there is no doubt the Sofi Stadium will have continued protection from corrosion over its life.

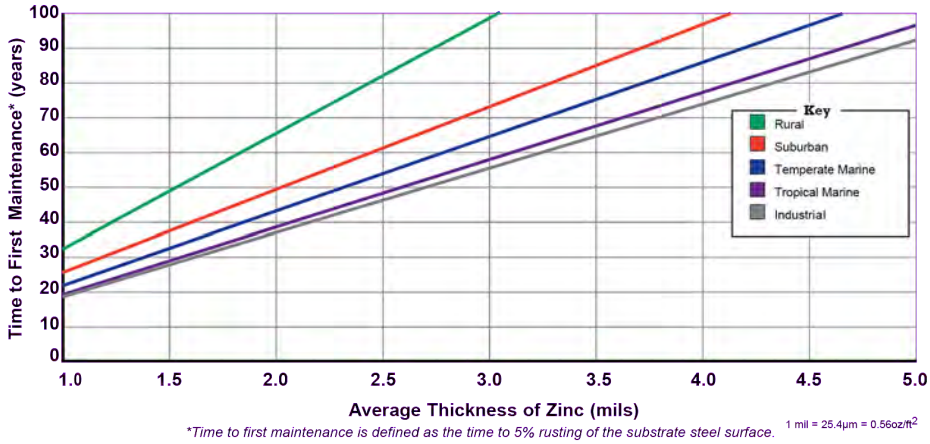


Figure 1. Average Thickness of Zinc plotted against the Time to First Maintenance: the thicker the zinc the longer time needed to first maintenance.


Cost-Comparison Report

The cost of galvanizing vs. a paint system

Cost Comparison

HDG vs. Polyurethane 100% Solids Elastomeric

	HDG	Paint System
Initial Cost Per m²	$58.13	$48.51
Initial Cost Total	$30,148.44	$798,060.07
Life-Cycle Cost Per m²	$58.13	$642.74
Life-Cycle Cost Total	$357,178.27	$3,949,133.87
AEAC Per m²	$1.76	$19.51

For this project...
HDG Life-Cycle Cost Savings: 90%

DETAILED COST COMPARISON
HDG vs. Polyurethane 100% Solids Elastomeric

Cost Of Galvanizing	Today's Cost	Net Future Value	Net Present Value
Original Galvanizing	$58.13	$58.13	$58.13
Total Price / m²	$58.13	$58.13	$58.13

Cost Of Paint System	Today's Cost	Net Future Value	Net Present Value
Original Painting	$48.51	$48.51	$48.51
Touch-Up - Year 14	$19.40	$29.35	$19.40
Maint. Repaint - Year 21	$33.96	$63.17	$33.96
Full Repaint - Year 28	$65.49	$149.83	$65.49
Touch-Up - Year 42	$19.40	$67.15	$19.40
Maint. Repaint - Year 49	$33.96	$144.52	$33.96
Full Repaint - Year 56	$65.49	$342.80	$65.49
Touch-Up - Year 70	$19.40	$153.63	$19.40
Maint. Repaint - Year 77	$33.96	$330.66	$33.96
Full Repaint - Year 84	$65.49	$784.30	$65.49
Touch-Up - Year 98	$19.40	$351.50	$19.40
Maint. Repaint - Year 105	$33.96	$756.53	$33.96
Full Repaint - Year 112	$65.49	$1,794.41	$65.49
Touch-Up - Year 126	$19.40	$804.21	$19.40
Maint. Repaint - Year 133	$33.96	$1,730.88	$33.96
Full Repaint - Year 140	$65.49	$4,105.48	$65.49
Total Price / m²	$642.74	$11,656.94	$642.74

PROJECT SPECS

Project Size
600.00 tons

Expected Life-Span
150 Years

Structure Type
Intricate - > 50' high

Member Type
Large Structural

Service Life Environment
Seacoast (C5M)

Paint System
1-Coat System comprised of:
Polyurethane 100% Solids Elastomeric, SP-3 surface prep. and 20mil minimum DFT.

Currency, Units & Assumptions
Calculations are based on metric units of measure and figured in USD.
Inflation and interest are figured at rates of 3% and 3%, respectively.

Figure 2. The Cost-Comparison between HDG and Polyurethane for a project like the SoFi Stadium. The estimate of a 150-year life span is a modest one seeing that similar Stadiums like the LA Memorial Coliseum are nearly 100 years old and still in use.

In 2021, the ASCE gave America's infrastructure a grade of C-, which indicates that the infrastructure, "is in fair to good condition; it shows general signs of deterioration and requires attention. Some elements exhibit significant deficiencies in conditions and functionality, increasing vulnerability to risk." To improve this score, the infrastructure needs to instead be in good to excellent condition with few signs of deterioration and deficiencies. The report breaks down the grade in detail and raises three Key Findings; the first point explains that, "maintenance backlogs continue to be an issue" and is largely due to complications in funding. While this is highly accurate of the infrastructure problem in America, a fundamental shift in approach can be beneficial, i.e. one that instead prioritizes investing in high-performance and low-maintenance infrastructure that will be less affected by maintenance and funding complications. Specifying more HDG will play a significant role in this shift, as it effectively eliminates these issues by reducing the cost and need for maintenance due to steel corrosion. Every year, the cost of corrosion in the US is $423 Billion, equivalent to 3.1% of the GDP. As described in the SoFi Stadium example, specifying more HDG will effectively protect steel infrastructure from corrosion, while freeing up more funding that can be re-invested into high-performance and low-maintenance infrastructure.

The ASCE's report also provided "Recommendations to Raise the Grade", with one of them being Resilience and the need to use, "new approaches, materials, and technologies." The HDG process is a perfect example of a material technology that needs to be more utilized to increase America's infrastructure resilience. The three-front corrosion protection method of the HDG technology effectively prevents corrosion, while the fundamentally different approach to performance and maintenance will allow for more resilient infrastructure in the US. This will successfully improve the general condition of America's infrastructure and ultimately increase the ASCE's infrastructure grade in future reports.

An additional "Recommendations to Raise the Grade" detailed by the ASCE's report is that of Investment; "If the United States is serious about achieving an infrastructure system fit for the future, some specific steps must be taken, beginning with increased, long-term, consistent investment." The Life-Cycle Cost Savings for the SoFi Stadium is a great example of the benefits of a higher initial investment, but is just a glimpse at the potential for a thriving and well-protected American infrastructure system. Unfortunately, effectively achieving this on a national scale is very unlikely without a new government Infrastructure Bill dedicated to investments such as galvanizing more steel. With today's construction attitude where the cheapest bid wins, investments in technologies like HDG are often cut, and the initially cheap methods result in expensive costs in the future. It is an unfavorable situation for everyone, as taxpayer money is spent inefficiently and America's infrastructure does not perform well overall.

High-performance buildings should not be limited to high-end projects like SoFi Stadium that have the private funding – every project that uses steel is susceptible to corrosion and should have the benefits of galvanization. With the way construction attitudes are today, it is difficult to make a substantial investment in HDG without legislative support. The recent bill passed by the US Senate in November of 2021, the Infrastructure Investment and Jobs Act (IIJA), is an incredible and exciting first

step for the future of HDG and America's Infrastructure as a whole. While the IIJA Bill and the Guidebook for it currently do not specifically detail investing in HDG, the IIJA or a potential Infrastructure Bill dedicated to galvanizing more steel would be an incredible opportunity to invest in high-performance and low-maintenance infrastructure such as HDG. With the barrier of HDG's higher Initial Cost removed, this would allow for an increase in specifying HDG and thus high-performing corrosion-protected steel. This would be an extremely effective long-term strategy as such an investment would provide substantial economic benefits that can be reinvested into further improving the resilience of America's infrastructure. The $423 Billion cost of corrosion, as well as the aesthetic and structural complications, would be greatly diminished long into the future. Ultimately, a government Infrastructure Bill that could fund the galvanization of steel would be a great investment in protecting our nation's infrastructure for generations to come.

References

America's infrastructure report card 2021 | GPA: C-. (n.d.). Retrieved March 30, 2022, from https://infrastructurereportcard.org/wp-content/uploads/2020/12/National_IRC_2021-report.pdf

ASCE's 2021 American Infrastructure Report Card: GPA: C-. ASCE's 2021 Infrastructure Report Card |. (2022, January 24). Retrieved March 31, 2022, from https://infrastructurereportcard.org/

Corrosion protection. American Galvanizers Association. (n.d.). Retrieved March 30, 2022, from https://galvanizeit.org/hot-dip-galvanizing/why-specify-galvanizing/corrosion-protection

Costs less, lasts longer talking points. American Galvanizers Association. (n.d.). Retrieved March 30, 2022, from https://galvanizeit.org/education-and-resources/publications/costs-less-lasts-longer-talking-points

Duplex systems: Paint or powder coating over HDG. American Galvanizers Association. (n.d.). Retrieved March 30, 2022, from https://galvanizeit.org/hot-dip-galvanizing/what-is-galvanizing/the-hdg-coating/duplex-systems1

Effects of corrosion. American Galvanizers Association. (n.d.). Retrieved March 30, 2022, from https://galvanizeit.org/corrosion/effects-of-corrosion

HDG environmental advantages. American Galvanizers Association. (n.d.). Retrieved March 30, 2022, from https://galvanizeit.org/hot-dip-galvanizing/is-galvanizing-sustainable/hdg-environmental-advantages

Hot-dip galvanized steel is Green: Life-Cycle Assessment supports... American Galvanizers Association. (n.d.). Retrieved March 30, 2022, from https://galvanizeit.org/education-and-resources/publications/hot-dip-galvanized-steel-is-green-life-cycle-assessment-supports-industry-c

Infrastructure Investment and Jobs Act (IIJA) implementation resources. Infrastructure Investment and Jobs Act (IIJA) Implementation Resources. (n.d.). Retrieved March 30, 2022, from https://www.gfoa.org/the-infrastructure-investment-and-jobs-act-iija-was

Powder. American Galvanizers Association. (n.d.). Retrieved March 30, 2022, from https://galvanizeit.org/corrosion/corrosion-protection/protective-coatings/powder

What is galvanizing? American Galvanizers Association. (n.d.). Retrieved March 30, 2022, from https://galvanizeit.org/hot-dip-galvanizing/what-is-galvanizing

What is the HDG process? American Galvanizers Association. (n.d.). Retrieved March 30, 2022, from https://galvanizeit.org/hot-dip-galvanizing/hdg-process