

# Galvanize the Future: Richard L. Brooks Memorial Scholarship

Sarah Olden  
BS Civil Engineering  
Colorado School of Mines (Sophomore)

America's infrastructure is arguably the most important and vital sector to today's society. It is essential that each individual have clean water, safe housing, and reliable transportation systems to live. Yet, each year it seems this sector lacks the appropriate funding to ensure the maintenance and improvement of these vital systems that continue to collapse.

In 2017, the American Society of Civil Engineers gave America's infrastructure a score of D+ (ASCE, 2017). This score represents the overall health of our infrastructure system, stating it is "poor" and "at risk." There are several reasons why our infrastructure system is in such poor condition. In February of 2017, the American Road and Transportation Builders Association stated that 55,710 bridges in the United States are structurally deficient (Sloan, 2018). Furthermore, failures and emergencies such as the Oroville Dam, Manhattan subway derailment, and harm from countless hurricanes have led to millions of dollars of damages and failing systems (Sloan, 2018).

To build new, repair old, maintain current, and rebuild broken infrastructure is not only a large task, but also an incredibly expensive one. Experts around the nation continue to state their differing opinions and attempt to prioritize projects. Unfortunately, there are just too many projects and prioritizing becomes impossible.

Many of the solutions presented have revolved around funding. Ideas such as increasing the gas tax to increase the Highway Trust Fund (Nichols & Holeywell, 2011) or attracting more private sector funding (Duvall, Palter, & Della Rocca, 2017) have been given. Of course, these are great ideas that have been proven to work in the past, but are still not leading us to the billions this country needs. An easier solution would be to not just increase funding, but to also lower the cost of maintenance and repairs.

Maintenance and repairs contribute to a staggeringly high percentage of America's infrastructure budget. In fact, between 2009 and 2011, 44.7% of the \$36.9 billion spent on traffic infrastructure paid for road repairs (Jaffe, 2015). During the 2017 fiscal year (2017-2018), a new budget for transportation has been announced, allowing for a total of \$98.1 billion to the Department of Transportation alone (Department of Transportation, 2017). At closer inspection, the government has allocated \$1.05 billion for transit improvement, \$700 million for rail maintenance, and \$44 billion to invest in the "critical infrastructure of the nation's highway and bridge systems (Department of Transportation, 2017)." These astounding appropriations would not be necessary if the United States dedicated more time and effort into creating higher quality and maintenance free structural designs.

There are several ways that this country can lower the cost of maintenance and repairs. Out of all of the options, hot-dip galvanizing is among the most realistic ways to decrease infrastructure cost leading to an increase in America's infrastructure quality.

Hot-dip galvanizing is the process of adding a layer of zinc to a piece of fabricated steel (American Galvanizers Association, 2018). This process is completed in six steps. First, soil and grease are removed followed by pickling, prefluxing, galvanizing, finishing, and most importantly, inspection (Rahrig, 1995). During the galvanizing step, steel is submerged into

large galvanizer kettles filled with zinc at temperatures between 435° and 454° C (American Galvanizers Association, 2018). The steel is submerged until the reaction between zinc and iron have completed, allowing a successful bond (American Galvanizers Association, 2018).

This incredible zinc coating protects the steel in two main ways. First, the tough, protective zinc envelope guards the steel beam from abrasion and damage (Digest of Equipment, Materials, and Management, 2010). Second, and most importantly, the zinc coating protects the steel from the environment, halting contact with humid air, the main cause of corrosion (American Galvanizers Association, 2018). Furthermore, if the steel is ever exposed to the elements, the surrounding zinc will react with the moisture, leaving behind an un-corroded steel beam intact (American Galvanizers Association, 2018).

It is no surprise that one of the leading causes of structural maintenance and even failure is due to the natural tendency of steel to rust in high humidity (Chatterjee, 2014). In fact, corrosion alone costs the United States over \$423 billion annually, or 3.2 percent of the gross national product, with indirect costs raising this value as much as 11 percent (American Galvanizers Association, 2018). The structural damages and repair are not the only cost when corrosion occurs. Traffic delays, accidents, excessive use of raw materials and energy (American Galvanizers Association, 2018) are also expenses that must be taken into account. For this reason alone, hot dip galvanizing can assist America's infrastructure dramatically.

However, hot-dip galvanizing is not only economically beneficial, but also environmentally friendly as well. Steel beams that are not galvanized become corroded and release detrimental chemicals into the environment. Unfortunately, the corrosion process can be exacerbated from the presence of chloride ions, oxygen ions, high temperature, high salinity and low pH (Malel & Shalev, 2014), conditions that are often found in the natural environment. Corrosion itself is incredibly detrimental to the environment. It is a harmful air and water pollutant that can lead to serious health problems to humans, plants, and animals (Kusmierk & Chrzescijanska, 2015). Corrosion can cause other both direct and indirect concerns as well, such as the Flint, MI water crisis, causing illness in countless individuals and, more specifically, elevated blood lead levels in children (Hanna-Attisha et al., 2016).

Using paint as a sealant is the only plausible alternative to galvanization used today. Unfortunately, paint is just as environmentally destructive, if not more, than not galvanizing at all. Not only is paint not as protective to corrosion as galvanizing, it can also release additional harmful chemicals into the surrounding environment (Digest of Equipment, Materials, and Management, 2010).

The combination of these environmental pollutants creates an additional economic cost. The cleanup of pollutants, medical costs, and much more add up to an even larger maintenance and repair bill, that in turn generates lower quality infrastructure.

Hot-dip galvanizing is not a new technique. For over 150 year, hot-dip galvanizing has proven to be an effective protection to steel beams and infrastructure systems (American Galvanizers Association, 2018). There have been countless projects that have proven how successful this process is to decreasing maintenance and increasing the longevity of structures. The Brooklyn Bridge is perhaps the most famous example. Over 100 years ago, the Brooklyn Bridge was built using over 14,500 miles of hot-dip galvanized wire to create the for main cables (American Galvanizers Association, 2018). Recently, the Brooklyn Bridge went under a large rehabilitation during which the hot-dip galvanized wire was thoroughly inspected and concluded to be in excellent condition (American Galvanizers Association, 2018).

In conclusion, America's infrastructure needs vast improvements. After receiving an overall grade of D+ in 2017 from the American Society of Civil Engineers, it is no surprise that changes need to be made. Improvements to our infrastructure will cost billions of dollars and countless years to repair. Policy makers have proposed many solutions, many of which include appropriating more funds to add a Band-Aid to an ever-growing problem. A more realistic solution would be to both increase funding and decrease the required expenses to maintain and repair our vital infrastructure systems. Hot-dip galvanizing is one viable solution that can help us meet this goal. Hot-dip galvanizing prevents corrosion, one of the major costs of repairs and major pollutants to today's society. Our infrastructure is among the most important systems we have in America, it is our job to protect it, and will in turn, protect our society.

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