Taking a Dip

Beth S. Pollak

As galvanizing plants increase in number and capacity, more designers than ever are choosing hot-dip galvanizing for long-term corrosion prevention.

While painting is the most common method of corrosion protection for steel, hot-dip galvanizing is gaining in popularity—especially as the initial price gap between painting and galvanizing closes. Hot-dip galvanizing is a process by which fabricated steel is coated with molten zinc that metallurgically bonds with the substrate steel beneath it. The zinc coating prevents corrosive elements such as water and salt from coming into contact with the steel, generally eliminating the possibility of rust.

The American Galvanizers Association (AGA) says that, in recent years, the demand for galvanizing of newly fabricated steel has increased. "The demand has increased about 5 percent for each of the last eight years," said AGA Executive Director Phil Rahrig. One reason is that the initial cost of galvanizing has decreased relative to the cost of other coatings. "The price of zinc, which is about 25 percent of a galvanizer's cost, has been stable or decreasing for the last 10 years," Rahrig said.

Another reason for the boost in galvanizing's popularity is that the number of galvanizers in the United States has grown, making the galvanizing process more accessible. "The capacity of the industry has increased dramatically in the last 10 years with the addition of more kettles, especially large ones that can galvanize structural fabrications up to 80′ long and 10′ wide," Rahrig said. "We've also done a better marketing job."

In addition to selling the short-term benefits of galvanizing, galvanizers focus on life-cycle cost and maintenance savings. "Owners are recognizing the validity of life-cycle costing, where galvanizing always comes out on top," Rahrig said. "There is no maintenance cost with galvanizing for at least about 30 years; so your initial cost is all you spend during that time frame. In contrast, paint has a repair cost about every eight years."

THE GALVANIZING PROCESS

Another advantage of galvanizing is a quick turn-around time. "A newly fabricated section with no rust should take only about an hour to be processed entirely," said Kevin Irving, of AAA Galvanizing, Inc. in Joliet, IL.

Items arriving to be galvanized at AAA's Joliet facility first are suspended on chains and slings for trans-

First step: organic material is removed by dipping steel in a hot caustic bath.

Steel exits the flux tank after being bathed in a solution of zinc ammonium chloride. The flux heats and coats the steel to prevent it from oxidizing.

AAA Galvanizing's 51' x 6'8" x 9'3" galvanizing kettle, filled with molten zinc heated to approximately 850°F.

Galvanized steel, cooling after immersion.

port through the plant. Hollow items to be galvanized internally as well as externally, like handrails and HSS, must be properly vented before they are galvanized to prevent the buildup of damaging pressure. Next, organic material is removed by dipping the steel in a hot caustic bath. AAA's Joliet plant currently uses an acid degreaser to achieve similar results. The steel is then placed in a pickling bath to remove any impurities on the steel's surface such as mill scale and oxides. "Any impurities on the steel—like rust, scale markings or paint—means that the zinc will not adhere to it later, and will result in 'black spots,'" Irving said.

While some galvanizers use a sulfuric acid pickling bath, AAA prefers hydrochloric acid. "It releases fewer acid fumes into the plant and is more environmentally friendly," Irving said. "Also, excess time in the sulfuric acid bath allows the acid to attack the base metal, which can deteriorate the steel."

After a rinse in water, the steel is placed in a flux tank, where it is bathed in a solution of zinc ammonium chloride. The solution heats the steel to 160ºF and coats it to keep it from oxidizing. Finally, workers dip the steel in the galvanizing kettle, which is filled with molten zinc heated to approximately 850ºF. Workers agitate the zinc in the kettle to ensure the steel is well covered, and that no ash byproducts, formed by the mix of iron and zinc, form on the steel. Once the steel exits the kettle, any excess zinc is removed before it hardens.

Before being shipped to the job site, the galvanized steel is inspected for compliance with ASTM specifications. Structural iron and steel is usually galvanized according to ASTM A123, and iron and steel hardware is galvanized according to ASTM A153.

Steel to be used in an acidic or chemically active environment is often painted with an epoxy coating after being galvanized to protect the zinc layer underneath. The zinc also provides underfilm corrosion protection for the paint. According to Irving, "This duplex system provides for an easy touch up of the paint to maintain and protect the base steel and the galvanizing, so you don't need to worry about blistering or corrosion."

LOOKING FORWARD

AAA, which recently hosted a site visit by AISC and *MSC* staff, was founded in 1995 at its Joliet plant. The plant is home to what was then the largest galvanizing kettle in the United States—51' long, 6'8" wide, and 9'3" deep (today, the largest kettle is A-Plus

In January 2003, A-Plus Galvanizing, Inc., in Salina, KS dipped what might have been the heaviest piece of steel ever galvanized in the world—an 86,000-lb. bridge tower anchor. Photo credit: John Gregory at Arrow Printing Company, Salina, KS.

Galvanizing's 82'-long kettle—for a list of galvanizers and their kettle sizes, see pages 60-66). In 1999 the company began operating a new high-tech plant in Dixon, IL with a slightly larger kettle; and in 2001 AAA expanded further to Hamilton, IN, where a new facility boasts North America's deepest kettle, 12'6" deep. The company recently galvanized 25 million lb. of steel for the Chicago Transit Authority's railway bridges and soon will be galvanizing about 35 million lb. more. "The CTA was tired of concrete and tired of paint—it just didn't work to prevent corrosion," Irving said.

In addition to bridge applications, galvanized steel can be used across different industries, Irving said. "Guard rails, bike racks, hand rails, chemical industry facilities, scaffolding, truck beds, boat trailers, structural supports, swimming pools, agriculture, power generation, transmission towers, stadiums, fasteners, HSS sections, tanks and rebar—if you're spending money, you want something that's going to last."

Irving says that there are numerous advantages to hot-dip galvanizing over other coatings. "Galvanizing offers cathodic protection, which means that when its surface is damaged, the zinc will sacrifice itself to bond and recover any exposed metal," he said. "It offers strong, uniform coverage of steel, that is not photochemically sensitive. It takes less than an hour to dry and is ready for immediate shipment directly to a job site. And quality is factory controlled and measured by inspectors."

BIG DIPPER

In January, A-Plus Galvanizing, Inc. of Salina, KS dipped what might have been the heaviest piece of steel ever galvanized in the world. An 86,000-lb. bridge tower anchor was galvanized in A-Plus' 82'×10'×12' super kettle. It is part of a steel-core reinforcing assembly for the concrete towers of a cable-stay bridge being built over the Olentangy River in Columbus, OH. A-Plus used a 50-ton crane to transport the steel section through the galvanizing process. "It was the heaviest dip we had ever done," said A-Plus Vice President Marilyn Mai-Stone. "Prior to that, the single heaviest was a 54,400-lb. railroad bridge beam."

Bridge designer David Jones of Jones-Stukey Ltd. in Columbus, OH says he chose galvanizing so the bridge will last. "We are trying to enhance its life span to more than 100 years," he said. "And we felt that the galvanizing of the steel would meet our goals. Galvanizing also was cheaper than paint, but until recently, there weren't dipping tanks that were large enough for members this big."

AISC-member fabricator PDM Bridge of Wausau, WI also favored galvanizing. "Half of the tower anchors were to be embedded in concrete," said PDM Project Manager Ray Iesalnieks. "So it was an access issue: the size of the boxes and the interior of the box would be difficult to metalize. Galvanizing was the only option."

However, Iesalnieks says that that is not always the case. "Very little of the bridgework we see is galvanized, unless for special applications like this. Most galvanizers don't have the capacity to galvanize a bridge girder."

But A-Plus was constructed with large capacities in mind. "With four 50-ton cranes, the facility was built to handle dips of this size," Mai-Stone said. "We get a number of calls from engineers in the design phases, and we let them know what we have. They've tried to work with local galvanizers, but are restricted by tank size. Now they're no longer restricted by the width or the length of their product."

As galvanizers increase their capacities to accommodate large dips, companies like A-Plus and AAA Galvanizing hope that designers take note. "Many people didn't take galvanizing seriously because there weren't any kettles big enough," Irving said. "Now the kettles are getting bigger and bigger, and they realize that galvanizers are serious about their product."

With fewer restrictions on kettle size and lifting capacity than ever, perhaps even more designers will consider galvanizing's promise of long-lasting corrosion protection–and send their steel for a hot dip. ★