A Winning Formula: Fabrication Painting Of Structural Steel Before Construction

Steel shipments for the building and construction markets are expected to exceed 37 million tons in 1997, up 3.4 percent from last year, according to industry sources. A significant amount of this increase can be attributed to industrial construction projects scheduled for this year. With many producers of chemicals, textiles and paper, and petroleum products reaching maximum capacity, construction of new plants or expansion of existing facilities is needed to keep up with demand. A growing trend in steel fabrication may affect the way the steel arrives at these construction sites.

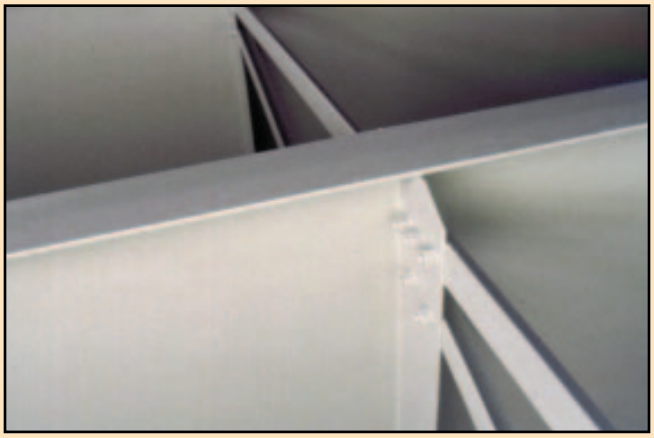
Putting a new twist on I-beam fabrication, more and more structural steel is arriving on the job site completely painted with multi-coat systems. Structural steel fabricators throughout the country are adding this service by creating advanced finishing lines in their facilities. There are numerous advantages to turning the job of painting steel beams, columns and trusses over to fabricators. They include time and budget reductions, as well as better compliance with environmental, safety and coating performance requirements.

Coating at the fabrication plant (in-shop painting) is a more efficient method of protecting new structural steel that is to be used in industrial plants with complex infrastructures and aggressive corrosive environments. A typical industrial structure can include thousands of pieces of steel, each serving a specific function. On the job site, not all the steel is easily accessible, and moving scaffolding and lift equipment to reach all exposed surfaces can be time-consuming. In addition, higher costs can be incurred by painting delays resulting from adverse application conditions, such as low temperatures and high moisure. Working around other trades, such as electricians, pipefitters and sheet metal workers, can also extend the painting process—making it more difficult to keep projects on schedule.

Along with the cost savings this process provides, comes the ability for better control over finish quality. In the corrosive environments of foundries, refineries and pulp and paper mills, coating protection is critical. Frequently, atmospheric conditions at the job site are less than ideal for surface preparation and painting. Uncoated steel is subject to flash rusting after blasting. Abrasive blasting, sweep cleaning and painting in the same day is required to minimize this problem. In many areas of a plant, however, abrasive blasting is difficult and costly to accomplish. Other concerns include moisture, dust and contaminants that can adversely affect adhesion and coating performance.

Meeting specified mil thickness levels is also important for good coating performance. Applying coatings after the steel has been erected, with less-than-ideal lighting and visibility, makes it difficult to achieve uniform coating thickness. In addition, coating inspection can be hampered by the inaccessibility of numerous surfaces.

In-shop or in-plant coating also addresses another important related



In-shop coating offers a number of application benefits, including better assurance of a uniform thickness, even in tight crevice areas.

painting issue: Environmental compliance. The volatile organic compound (VOC) emissions of industrial and marine coatings are regulated by federal, state and local agencies. When the painting is conducted at a permitted fabrication facility, compliance is simplified.

Recovery & Oxidation Systems

Air-purifying equipment not available in the field can be employed in fabrication plants to further reduce air pollutants. The two most common purifying methods are recovery and oxidation. With recovery systems, exhaust air is filtered using either heat exchangers, cold spray contact condensers or adsorption scrubbers. Solvents reclaimed from these systems are separated and reused. Under the oxidation method, VOC emissions are reduced by combustion. Thermal, recuperative and catalytic are the simplest and most cost-effective oxidation techniques.

Automating the Painting Process

A company that has experienced firsthand the growth of in-plant coating is the Kline Iron & Steel Company of Columbia, SC. Kline Iron & Steel was founded as a metal working facility in 1923 by Philip and Meyer Kline. The company entered into the fabrication steel business during World War II, when it received a number of subcontracts for the U.S. Navy. During the post-war expansion years, Kline began fabricating and erecting steel for textile and heavy industrial projects, becoming a major contributor to industrial development in the Southeast U.S.

Today, Kline's projects span the country and include everything from airline hangars, office towers and sports complexes to breweries, manufacturing plants and pulp and paper mills. Operations have been expanded to two sites with a combined total of 380,000 ft^2 of production and warehousing space. Within the last 20 years, the company has made large investments in new equipment to modernize its operations. This includes a comprehensive computer system, CNC burning and drilling equipment and an advanced finishing system capable of applying high-performance multi-coat paint systems.

According to Bob Glass, Kline's sales manager, the finishing department provides the company with a significant competitive advantage. "Applying multi-coat paint systems to steel for use in corrosive environments is a highly technical and capital-intensive process. For these reasons, few companies are capable of offering such specialized services. We've been providing this service to our customers for a number of years, and are receiving more and more orders every day for two- and three-coat systems," said Glass.

By eliminating the need for lifts or scaffolding, coatings can be applied in a fraction of the time compared to conventional on-site application.

**Zinc Clad™ IV, Sherwin-Williams Co., Cleveland, OH.*

In its finishing operations, Kline uses a variety of coating systems to address a range of environments. Water-based and high-solids coatings, however, are used whenever possible to minimize VOC emissions. As a permitted paint site, the plant records VOC emissions on a daily basis. The company also works closely with representatives from Sherwin-Williams Co., as well as its coating suppliers, in order to select environmentally friendly substitutes for traditional high-VOC solvent-based coatings.

Better surface preparation is one of the reasons why design engineers specify the application of coatings in Kline's plant. The company utilizes both sand-blasting and shot-blasting systems for efficient and high-quality surface preparation on a broad spectrum of sizes and shapes of steel. The special blasting unit uses an abrasive mixture comprised of steel shot and grit to prepare the steel to a specified surface condition. It also creates uniform surface profiles that enhance coating adhesion.

After blasting, the grit/shot mixture is collected by means of an in-floor conveyor system. The reclaimed abrasive mix is then filtered for re-use. Metal particles, dust and blast debris too small for re-use are trapped in the system's baghouse and eliminated. Recycling the blast media allows Kline to significantly reduce its waste disposal costs.

Significant cost savings can be realized by in-shop coating of structural steel, partly because enhanced application efficiency and the elimination of delays caused by adverse conditions.

Steel that has been properly prepared is placed in a thermostatically controlled area for painting. Unlike painters working at construction sites, Kline's paint crews do not have to be as concerned about moisture, dust and other contaminants adversely affecting coating application or performance. In addition, they can easily coat even intricate fabricated steel without lifts or scaffolding, and can apply the coatings in a fraction of the time. On average, only 1.3 man-hours are required to apply a single coat to a ton of steel. Equipped with four airless sprayers and a flame-sprayed zinc unit, the plant has the capacity to coat between 40 and 80 tons of steel per day.

After the coatings have cured, each job undergoes strict inspections, with the results completely documented at each quality hold point. Kline's quality control manager, Larry Dowd, makes sure that every piece of steel leaving the plant meets the customer's specifications. "We pride ourselves on being thorough," Dowd said. "Unlike inspectors in the field, we can closely examine every surface."

Dowd and his crew develop quality logs on every lineal foot of steel scheduled for coating. At the time of painting, the applicator's name, the coating manufacturer's batch numbers, the type and percentage of thinners used and the paint's atmospheric conditions are all recorded. After application, the finishes are inspected for compliance with dry film thickness requirements and flaws, such as skips, voids and holidays. All flawed areas are tagged and repaired.

Along with simplifying the application process, in-shop coating also makes the job of inspection much easier.

Proven Results

The enhanced quality offered by Kline's in-plant painting department was evident in a recent fabrication project for the construction of a paper mill. Awarded to Kline by Brown & Root, an engineering and design consulting firm, the project involved 4,000 tons of steel that was fabricated into trusses and other structural roof

supports on the wet and dry ends of the paper machine building.

For Mike Smyth, project engineer for Brown & Root, surface preparation and coating performance were major design concerns. “Pulp and paper mills present some of the most aggressive environments,” Smyth said. “Large volumes of water are used, causing condensation to form on structural beams. Chlorine, liquors and acidic sulfur dioxide fumes are also typically present, creating hostile environments for steel structures,” he continued. “Protective coatings are the first and last line of defense.”

In addition to a corrosive environment, pulp and paper mills are generally in continuous operation. Shutdowns to make repairs are rare, and when performed are very costly. Because of this, Smyth wanted a coating system that would not need to be repaired anytime soon.

Working with Kline, Brown & Root engineers made recommendations on acceptable systems. Kline tested the application properties and finish quality of each by conducting sprayouts. Based on the design requirements established, three coatings were selected.

On steel beams and trusses to be employed in the wet end of the plant—where humidity levels averaged 95 percent—a three-coat system was specified. A two-component polyamide epoxy zinc-rich primer* was used as a basecoat. The primer contained 85 percent zinc dust by weight, and provided excellent surface tolerance for effective sacrificial protection at the steel surface interface. An intermediate coat was also applied. It was a polyamide/bisphenol A epoxy, formulated to achieve a high build for added corrosion resistance and durability. The topcoat was a high-solids, two-compound polyurethane. In addition to being VOC-compliant (2.4 lb/gal mixed), the coating offered superior chemical, corrosion and impact resistance as a result of an advanced polymer makeup. The coating’s lower molecular weight polymer and co-reactant permitted greater crosslink density for a harder, less-permeable paint film.

The total dry film thickness for the three-coat system ranged between 8 and 11.5 mils. Structural steel for the dry area of the paper mill, which would be exposed to only moderate corrosive conditions, was protected with a two-coat system composed of the primer and intermediate coatings utilized in the three-coat system (a zinc-rich primer and two-component polyamide epoxy). The dry film thickness for this system was specified to range between 6.5 and 9.5 mils. Both coating systems were designed to provide 20 years of service.

Kline fabricated and coated the steel for the mill in less than three months. By bar coding each piece of steel, Brown & Root engineers were better able to inventory steel arriving at the job site. It also made assembly much more efficient. Because of the advanced material handling methods employed to transport the steel from Kline’s plant to the job site, only minor coating touch-ups were required on-site. The beams were hoisted into position with the help of a crane fitted with nylon lifting straps. The end result was a more chemical- and corrosion-resistant finish, created for a fraction of the cost and in less than half the time as on-site painting.

A nice finish to a complicated project. P&SF