

Recommendation for Utilizing Hot-Dip Galvanized Steel

Project Description:

The project is to design a rooftop platform and walkways to be incorporated into a new green roof for a school building. Steel-frame construction will be utilized for the platform and walkways. An approximately 3,000sf area of the roof will be vegetated, and will require access for its regular maintenance. The walkways will provide access for maintenance of the green roof, as well as allow students to explore the vegetation. The platform will provide a space for people to gather and classes to be held. The project life is estimated to be 50 years.

Introduction:

This proposal recommends the use of hot-dip-galvanized (HDG) steel for the construction of the rooftop platform and walkways. Utilizing HDG steel will provide superior corrosion protection, compared to paint-coated steel, thus achieving significant cost savings and maintaining the integrity of the structure throughout its lifespan. Corrosion-related maintenance and repairs represent a substantial expense, as they require considerable labor, energy and material inputs. Reliable corrosion protection is therefore essential for managing the overall cost and sustainability of this project, as well as ensuring the safety of the school community. The benefits of utilizing HDG steel will be discussed in more detail below.

Durability and Safety:

Providing a safe environment is one of the most important responsibilities of a school. The reliability of corrosion protection has a large effect on the durability of construction materials, and thus the safety of an entire structure. In the current project, when classes are held on the green roof the platform and walkways will be subjected to heavy traffic. A serious safety hazard will result if their structural strength is compromised by corrosion. It is therefore imperative that reliable corrosion protection is employed in this project. A structural failure of the rooftop platform and walkways may result in serious injury and would also necessitate costly repairs of the roof structure and the green roof system.

As foot traffic will subject the structure to abrasion, which could damage the protective coatings, the corrosion protection system utilized in this project must be highly abrasion-resistant. The more abrasion-resistant the coatings are, the more reliable corrosion protection they will provide. In the process of hot-dip galvanizing, the base steel is immersed in a molten zinc bath, creating a metallurgical bond between the steel and the layers of zinc-iron alloy. This galvanizing process results in a coating with a bonding strength approximately five to seven times greater than that of paint coatings. Moreover, the layers of zinc-iron alloy are harder than the substrate steel, thus creating a highly protective barrier between the steel and the environment. Hot-dip-galvanized steel is therefore much more resistant to damage from abrasion than paint-coated steel.

Additionally, the zinc-iron alloy layers cathodically protect the substrate steel. In other words, the zinc layer sacrificially corrodes before the steel, until the zinc is fully consumed. For this project, considering the structure's proximity to the vegetated surfaces and corrosive substances, such as water, soil, and fertilizers that may contain chlorides or sulfides, the protective characteristics of the zinc coating make HDG steel a better choice than paint-coated steel.

Sustainability:

This project, with its associated green roof, will both literally and figuratively constitute a platform for environmental education. Students will enjoy a living example of the natural life-cycles of plants and animals, while also learning about contributions to sustainability, such as the reduction of heat-island effects, provision of natural habitat, and stormwater management. Hot-dip-galvanized steel is a fitting choice for this project as both steel and zinc are 100% recyclable at the end of their life, while paint coatings, on the other hand, will become permanent waste after their use. The use of HDG steel therefore makes an important contribution to the conservation of resources and the reduction of waste.

The longevity of the materials used in this project is also an important consideration in achieving sustainability. In the hot-dip galvanizing process, the zinc coating develops perpendicular to the surface, which forms a barrier of equal thickness on all areas. It therefore provides better protection than paint coatings, which may vary in thickness. The complete immersion of steel in the zinc bath during the HDG process also enables the complete coverage of all surfaces, regardless of their shape, thus strengthening the integrity of the coating. These features increase the longevity of the HDG coating, and greatly extend the period before maintenance is first required. Hot-dip-galvanized steel does not generally require its first maintenance for 75 years or more, while paint-coated steel typically requires maintenance in a cycle of 12 to 20 years. Therefore, during the 50-year life of this project, there will be no maintenance required for the HDG steel, while paint-coated steel would require repeated maintenance. Considering that it would consume energy and materials, as well as generating gas emissions and solid waste, the environmental impact of such routine maintenance is significant. In addition, unlike some paint coatings, HDG coatings do not generate gas emissions during use. Choosing highly recyclable and long-lasting hot-dip-galvanized steel will therefore contribute to the reduction of the project's overall environmental impact.

Cost Effectiveness:

Cost considerations can greatly limit the choice of materials. The most cost-effective choices, however, are not necessarily those with the lowest initial cost. In order to consider the true cost of the project, the costs associated with operation, maintenance, repair, replacement, salvage and disposal over the life of the project (Life-Cycle Cost) must be taken into account. In fact, corrosion-related maintenance costs can amount to two- to five-times the initial cost of a project. The National Association of Corrosion Engineers (NACE), the Federal Highway Administration (FHWA), and C & C Technologies estimate that the annual direct cost of corrosion equals 3% of US GDP. The indirect costs, including traffic delays, lost commerce, injuries and damage, etc, is estimated to be five- to eleven-times greater than the direct costs. Applying effective and reliable corrosion protection is therefore an essential strategy to reduce overall project costs.

Based on the Life-Cycle Cost Calculator provided by the American Galvanizers Association (AGA), the life-cycle cost savings of utilizing a hot-dip-galvanized steel structure is approximately 90%, compared to the 3-coat paint system comprised of two coats of epoxy and a topcoat of polyurethane. Given our project's 50-year life span, the life-cycle cost of the hypothetical 1,000sf of HDG steel is estimated to be \$1.76 per square foot. On the other hand, the life-cycle cost of utilizing the 3-coat paint system for an equal surface area is estimated to be \$21.20/sf, or approximately 12 times the cost of HDG steel. This large difference reflects the significance of maintenance costs when using non-HDG steel.

Furthermore, the initial cost of utilizing HDG steel is not necessarily more expensive than paint-coat systems. In the above example, the initial cost of HDG steel is estimated to be \$1.76/sf, while that of the

3-coat paint system is estimated to be \$4.51/sf. By carefully examining the costs, we see that hot-dip-galvanized steel can be the most economical choice from the beginning of a project.

Another benefit of utilizing HDG is that potential damage to the green roof system can be avoided. Because the platform and walkways will be built over and adjacent to the vegetated surfaces, carrying out maintenance on these structures will necessarily entail a chance of damaging the green roof system, which may then require costly repair. Hot-dip-galvanized steel, which will require no maintenance during the project's life span, is therefore an ideal choice for reducing the risk of potential damage to the green roof.

Summary:

Hot-dip-galvanized steel has considerable benefits compared to paint-coated systems. Considering the nature of this project, in which the steel platform and walkways are incorporated with the green roof, HDG coating will provide superior corrosion protection and thus more reliably reduce the risk of potential safety hazards. Utilizing hot-dip-galvanized steel for the platform and walkways is therefore highly recommended, as it will ensure provision of a safer and more sustainable environment, while achieving a manageable project cost.