The Better Choice

BY PHILIP G. RAHRIG

Galvanized steel parking structures are stong contenders in today's parking market.

GIVEN THE STATE OF RISING COSTS FOR CONCRETE CONSTRUCTION MATERIALS, protracted delivery schedules for precast, and shrinking maintenance budgets, many owners are requesting a viable alternative parking structure design. Steel is such an alternative and although surrounded by many misconceptions, its strengths position it as a long-term solution.

For a number of qualitative performance-related reasons, steel—and in particular hot-dip galvanized steel—is a good choice for many parking structures. Here are my top 10 reasons you should consider a galvanized steel parking structure:

1 Galvanized steel has demonstrated a verifiable durability for decades in a variety of environments, including coastal and industrial. Learn more in the SteelWise article "Are You Next" in the September 2006 issue of MSC at www.modernsteel.com.

2 Castellated beams often used in steel design create an open and light-filled atmosphere where patrons feel safer.

3 Galvanized reinforcing steel in decks means no unsightly spalling and no corroding seams between deck panels.

4 Steel garage construction schedules are shorter.

5 Galvanizing of 60-ft to 80-ft girders is now common, accommodating almost all designs. The actual turnaround time to galvanize is usually less than five working days.

6 Steel designs are overall lighter in weight, meaning fewer and/or smaller caissons.

7 Galvanized coatings are aesthetically appealing not only for the structural members, but also for stairways, exterior mesh panels, and guardrails.

8 Painting structural steel means costly, scheduled maintenance and lost revenue. Galvanized steel is maintenance-free for 50–80 years.

9 Life-cycle costs of galvanized steel frame parking structures are two to three times less than precast. Life-cycle costs of galvanized steel frames are two to five times less than painted structural steel frames.

10 Galvanized steel framing is initially 10%–20% less expensive than precast construction.

Initial Cost

Once the qualitative analysis reveals that a galvanized steel frame is maintenance-free for decades and does prevent corrosion for many decades, even in harsh coastal climates, the owner's next step in the decision process is to develop the quantitative analysis and evaluate exact initial costs. The table on the next page illustrates the cost of hot-dip galvanized frame design compared to precast concrete design.

Life-Cycle Cost

Even though the initial cost of galvanized steel is favorable to precast concrete, responsible design requires the investigation of other coatings to protect the steel from corrosion. Although not necessarily the case, various paints are generally viewed as initially less expensive than hot-dip galvanizing, and while initial cost is often the decisive factor when selecting a corrosion protection system for steel a garage, there are other costs that dwarf this initial funding outlay. Those costs are associated with a series of scheduled maintenance costs necessary to protect the steel from corrosion over the planned service life. For maximum protection of the asset, plans should be based on an ideal maintenance cycle. For paint systems an ideal cycle calls for touch up, maintenance painting, and full-repainting prior to visual evidence of substrate steel corrosion. However, on most projects a practical, less rigorous cycle is used, and this means maintenance is conducted when the coating has deteriorated to the point where the project looks to be in disrepair and iron oxide (rust) is visibly evident. For a hot-dip galvanized corrosion protection system, maintenance is normally not required.

To determine the timing of practical maintenance, most paint coating systems have been tested in a laboratory using accelerated corrosion mechanisms. To be sure, if the testing indicates that a touch-up painting should be performed in year eight, a maintenance paint applied in year 13, and a full repaint in year 18, the actual project may require maintenance according to the wear and tear on the project and the toll environmental corrosive elements have taken. That may mean earlier-than-planned maintenance based on the accelerated testing.

Comparing one system to another can be an arduous number-crunching exercise further complicated by the various performance characteristics each coating system provides. A three-coat inorganic zinc-epoxy-polyurethane system may have initial durability, while hot-dip galvanizing provides corrosion protection inside hollow structural sections, and alkyds may be the standard of past projects. But once the field is narrowed to a couple of optimal coating systems according to desired performance, it is important to use all the financial tools and models available to quantify future costs as accurately as possible, especially with maintenance budgets shrinking and substantial long-term costs.

One tool is the Life-Cycle Cost (LCC) Calculator now available at **www.galvanizingcost.com**. As the URL implies, this site will compare the initial and life-cycle costs for over thirty (one-, two-, or three-coat) paint systems to hot-dip galvanizing. A unique feature of the software is that it allows the user to customize the input to fit his/her particular project exactly. Input variables include total size in tons or square feet, surface preparation type, structural steel component size (small, medium, large), and planned service life of the project. The calculator allows the user to input in either metric or U.S. units.

The primary driver and input variable of the life-cycle cost calculation is the corrosion data for the project's environmental location. If a parking structure is in a rural area, corrosion rates are low because of lower corrosive elements in the air. For a garage in an industrial area, aggressive corrosion may be initiated by sulfide and chloride emissions from production plants, including high levels of automobile/truck exhaust. There are four input options for the environment and all correspond to categories described in ISO 12944-2 "Classification of Environments."

The financial component of the LCC Calculator is also customizable and based on standard net future value (NFV) and net present value (NPV) calculations where the time value of money is considered. The user selects what rate of inflation is projected over the life of the project in order to determine the value of money at each maintenance time, and the average interest rate future expenditures on maintenance could earn—i.e., lost opportunity cost. Both are used to calculate the more easily understood and meaningful average annual equivalent cost (AEAC) for each coating system being modeled for any specific project.

NFV = initial cost[(1+*i*)*n*}, where *i* = inflation; *n* = project life in years

NPV = NFV[1/(1+*i*)*n*], where *i* = interest rate; *n* = project life in years

AEAC = NPV[*i*(1+*i*)*n*/(1+*i*)*n* – 1], where *i* = interest rate; *n* = project life in years

The information on the cost of each paint system and its practical service sequence in

Comparison of Initial Costs

City	Concrete Cost[1] ($/sq. ft.)	Concrete Cost[2] ($/sq. ft.)	HDG Cost Range[3] ($/sq. ft.)
Atlanta	33.85	37.77	28.65 – 32.23
Baltimore	37.21	42.04	31.70 – 35.66
Boston	46.28	48.84	38.05 – 42.80
Charlotte	not available	32.32	25.86 – 29.09
Chicago	43.43	47.19	36.25 – 40.78
Cleveland	40.34	42.42	33.10 – 37.24
Denver	38.14	40.48	31.45 – 35.38
Dallas	33.68	35.66	27.74 – 31.20
Detroit	42.11	45.33	34.98 – 39.35
Kansas City	41.30	43.73	34.01 – 38.26
Los Angeles	42.91	45.12	35.21 – 39.61
Miami	34.81	36.59	28.56 – 32.13
Minneapolis	45.03	47.40	36.97 – 41.59
New Orleans	34.73	36.50	28.49 – 32.05
New York	52.49	55.73	43.29 – 48.70
Philadelphia	45.83	48.33	37.66 – 42.37
Pittsburgh	39.05	42.33	32.55 – 36.62
St. Louis	41.68	43.22	33.96 – 38.21
San Francisco	48.84	51.42	40.10 – 45.12
Seattle	41.74	44.02	34.30 – 38.59
National Average	**41.23**	**42.25**	**33.39 – 37.57**

[1]RSMeans, Reed Construction Data
[2]Parking Structure Cost Outlook for 2007 - "An Inconvenient Truth," Joey D. Rowland, P.E.
[3]American Institute of Steel Construction - estimate

LIFE-CYCLE COST CALCULATOR
Life Cycle Maintenance Cost

Data Input:

IPI University Parking Garage

English Units
USA US Dollar/ Conversion Factor: 1
IOZ/ Epoxy/ Polyurethane (21-year Service Life)
40 year projected life

Environment: C3: Medium Corrosion
Structural Member Type: Large Structural

Primer: IOZ
Surface Prep: SP-10 Automated (0.38)
Applied: PracticalSpray (0.212)
Primer Product: Zinc Rich Primers (0.50)

Intermediate Coat: Epoxy
Applied: PracticalSpray (0.172)
Location: Shop
Product: Two-Pack Products (0.48)

Topcoat: Polyurethane
Applied: PracticalSpray (0.304)
Location: Shop
Product: Two-Pack Urethanes (0.51)

Steel Area: 250,000 Sq Feet OR 2,500 Tons

3% inflation
6% interest

Paint Operation
Paint Initial Cost/Sq Feet: 2.43

Painting Operation	Original Painting	Touch Up Year 21	Maintenance Repaint Year 28	Full Repaint Year 39	Total
Cost in Current Currency	2.43	1.46	2.55	4.98	11.42
NFV costs futures value at 3% inflation	2.43	2.71	5.84	15.78	26.76
NPV costs present value at 6% interest	2.43	0.80	1.14	1.63	6.00

Average Equivalent Annual Cost/Sq Feet = $0.40
Total Paint Project Cost: $1,498,991

HDG Operation
HDG Initial Cost: 0.19/lb OR 3.80/Sq Feet

Galvanizing Operation	Original Galvanizing	Total
HDG in Current Currency/Sq Feet	3.80	3.80
NFV costs future value at 3% inflation/Sq Feet	3.80	3.80
NPV costs present value at 6% interest/Sq Feet	3.80	3.80

Average HDG Equivalent Annual Cost/Sq Feet = $0.25
Total HDG Cost: $950,000

The Delaney Square parking structure in Orlando, Fla. features a galvanized steel frame.

years for each of the ISO environments is contained in a database.* Based on the user's selection of a particular coating system, the software accesses the appropriate field and incorporates the data into the life-cycle calculation. There are two options for the cost information of hot-dip galvanizing, also resident in a database. The user may either select the default, which is a U.S. average cost, or input any number in dollars per lb or dollars per kg, based on local market information.

Output of the LCC Calculator includes a printable summary of all selected input as well as tables containing the initial, NPV, total project, and AEAC for the coating system and hot-dip galvanizing. The LCC Calculator output is available in U.S. dollars or in any country's currency. The currency conversion is real-time, making the LCC Calculator useful for export/import projects. MSC

Philip G. Rahrig is the executive director of the American Galvanizers Association.

The text of this article originally appeared in The Parking Professional *(November 2007).*

Note

*NACE Paper #06318, "Expected Service Life and Cost Considerations for Maintenance and New Construction Protective Coating Work," Helsel, Melampy, & Wissmar, KTA-Tator, Inc. 2006.