Technical Paper
An Example of a Life Cycle Costing Analysis

The economics of hot dip galvanizing, including duplex coatings (hot dip galvanizing + a suitable series of top paint coatings over galvanizing) versus a good specification paint coating system for corrosion control of carbon steel, is the subject of much debate.

The economics of any corrosion control (protection) system cannot and should not be based on initial costs, but rather on the life cycle costs of the protective coating. Life cycle costings can become extremely complicated being dependent on numerous variables that the analyst wishes to include in the calculation.

The following life cycle costing analysis has been simplified by limiting such variables to identifiable, accepted and published variables. Corrosion control systems and life cycle performance is a function of the environment in which the specific corrosion control system is required to serve. For purposes of this specific life cycle costing analysis the following criteria has been used.

Environmental and Corrosion Rates

Table No.1
Atmospheric corrosive environments classified in terms of ISO 9223, similar to ISO 14713 and ISO 12944 for paints

Classification	Description	Corrosion rate of Steel (µm/yr)	Corrosion rate of Zinc (µm/yr)
C1	Interior: Dry benign environment	≤1.3	≤0.1
C2	Interior: Occasional condensation. Exterior: Urban inland or mild	>1.3 to 25	0.1 to 0.5
C3	Interior: High humidity, some air pollution. Exterior: Urban inland or mild coastal	>25 to 50	0.5 to 2
C4	Interior: Swimming pools, chemical plants, etc. Exterior: Industrial inland or urban coastal.	>50 to 80	2 to 4
C5	Exterior: Industrial with high humidity or high salinity coastal.	>80 to 200	4 to 8

Table No.1 (ISO 9223) defines the corrosion rates of steel and zinc. From this data one can estimate the approximate length of time to perforate a given thickness of steel, and more specifically the service life of a given thickness of a hot dip galvanized (zinc) coating.

Table No.2
ISO 12944 – Classification of Environments

Classification	Corrosivity	Exterior	Interior
C1	Very low		Inside heated building with natural atmospheres, offices, shops, schools, hotels
C2	Low	Atmospheres with low pollution And dry climate. Mostly rural areas	Unheated buildings where condensation may occur. Depots, sports halls
C3	Medium	Urban and industrial atmospheres, moderate sulphur dioxide pollution. Moderate coastal climate	Production rooms with high humidity and some air pollution. Food processing plants, laundries, breweries, dairies
C4	High	Industry and coastal areas	Chemical processing plants, swimming pools, boat yards over sea water
C5 - I	Very high Industry	Industry with high humidity and aggressive atmospheres	
C5 - M	Very high Marine	Marine coastal, offshore, high salinity	

Scope of the Costing Analysis

The example will compare the life cycle costs of hot dip galvanizing, duplex coatings (hot dip galvanizing plus a suitable top paint system) and a three-coat paint system in a C4 environment as defined in ISO 9223 and ISO 12944.

Costings and Specifications as at September 2006

Hot dip galvanizing costs, based on the current zinc price of R25,000 per ton, will approximate to a selling price between R2,700 per ton to R3,100 per ton, depending on gauge. In order to simplify the calculation, R2,800 per ton of medium to heavy gauge steel has been used. (6 and 8mm thick steel plate). Converting this price per ton to a price per square meter of surface we have the following.

Table No.3
Approximate Pricing of Hot Dip Galvanizing

Hot dip galvanized as per SANS121 (ISO1461)	6mm	8mm	Min. Coating Thickness (µm)	Mean Coating Thickness (µm)
Surface area (both sides)	42 m²/ton	32m²/ton		
Price per square meter	R66.67 per m²	R87.50 per m²	75	85

Table No.4
Approximate Pricing of a Duplex Coating System

HDG + 3 coat top paint	Description	Price/m² 6mm	Price/m² 8mm	Min. Coating Thickness (µm)	Mean Coating Thickness (µm)
Primer	HDG to SANS121 (ISO 1461)	R66.67 per m²	R87.50 per m²	75	85
Preparation for paint	Sweep blast with non-metallic shot < 2 bar pressure	R20.00	R20.00		
Intermediate Coat	High build epoxy	R30.00	R30.00	75	110
Finishing Top Coat	Polyurethane colour	R27.00	R27.00	40	50
Totals	**Duplex Pricing**	**R143.67**	**R164.50**	**190**	**245**

Please note that the prices quoted do not in any way represent the actual prices given by member galvanizers, but are estimates used for the purposes of costing analysis. The higher, and more conservative, price for hot dip galvanizing has been used in the calculations.

Estimated costs of the paint system were obtained from a reputable painting contractor.

Table No.5
Approximate Pricing of a Three-Coat Paint System

Three-Coat Paint System (All gauges)	Description	Price/m²	Minimum (DFT) Coating Thickness (µm)	Mean (DFT) Coating Thickness (µm)
Preparation	Shot blast to Sa2½	Included in the primer price		
Primer	Inorganic zinc rich with min. 81% zinc content	R70.00/m²	50	75
Intermediate Coat	High build epoxy	R30/m²	75	110
Finishing Top Coat	Polyurethane colour	R27.00/m²	40	50
Totals		**R127.00/m²**	**165**	**235**

Service Life or Life Cycle Costs of the Three Defined Systems

From ISO 9223 (Table No.1), three environments have been selected, i.e. C2, C3 and C4 for purposes of the life cycle costing analysis. These three environments are described in tables Nos. 1 & 2 above. We will use 8mm steel for the pricing of hot dip galvanizing.

Table No.6
Life Cycle of the Three Systems (Years to 5% rust or Life to 1st maintenance)

Coating System	C2	C3	C4
Hot Dip Galvanizing (85µm)	170+	42 to 170	21 to 42
Duplex Coating	Not required for corrosion control	Not required for corrosion control	46 to 78
3 x Paint system	12 to 15	10 to 12	10

Table No.7
Life Cycle Costs, based on Life to 1st Maintenance

		Net Rate per year of life to 1St maintenance		
Coating System	**Prices/m²**	**C2**	**C3**	**C4**
Hot Dip Galvanizing (85µm)	R87.50	R87.50 / 170yrs R0.515	R87.50 / 42yrs R2.083	R87.50 / 21yrs R4.166
Duplex Coating	R164.50	Not required	Not required	R164.50 /46 yrs R3.576
3 x Paint system	R127.00	R127.00 / 12yrs R10.583	R127.00 / 10yrs R12.700	R127.00 / 10 R12.700

Should one wish to now estimate the figures for a C5 environment, we would have the following approximations.

C5 - Exterior: Industrial with High Humidity or High Salinity Coastal.

Hot dip galvanizing on its own would last between 10 to 21 years, with a net cost per year to 1st maintenance of between R4.166 to R8.75, i.e. R87.50 / (10 to 21yrs).

Duplex would extend the life cycle to between 30 to 46 years with a corresponding life cycle cost of R3.576 to R5.483 per year, i.e. R164.50 / (30 to 46yrs).

A three-coat paint system is estimated to last 10 years, with a corresponding life cycle cost of R12.70 per year, i.e. R127.00 / 10yrs.

The above figures are conservative and do not account for future values or the cost of 1st maintenance, such as escalation and plant downtime costs (i.e. lost production during shutdowns), scaffolding, cleaning and recoating a structure as built.

Conclusion

A three coat paint system is 255% more expensive than the Duplex System – System in a C4 Environment calculated as follows:

$$\frac{\text{(Paint System R12.700)} - \text{(Duplex System R3.576)}}{\text{Duplex System R 3.576}} \times 100\ \%$$

Paint System = 255% more expensive than Duplex system

As a footnote, a quality Duplex Systems should include input of the asset owner, Hot Dip Galvanizers Association, Paint Manufacturer and the Applicator at the design stage of the project.

Project engineers, property owners and developers should seriously consider life cycle costs and not base values and project decisions on only the initial costs. Balancing design in order to meet environmental conditions is essential in the determination of the corrosion control system that is selected for a given project.

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