RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Tools and Techniques for Evaluating the Cost of Corrosion Control on Penstocks and Gates

Economic analyses of protective coatings and cathodic protection systems in protecting Reclamation's steel structures

Research Bulletin
Science and Technology Program
4724

The cost of corrosion can now be evaluated using a Microsoft Excel spreadsheet tool. One approach features a life-cycle cost analysis of protective coatings options. A second approach calculates the break-even point for cathodic protection systems. Future econometrics work is needed to derive cost-driving factors and develop a cost forecasting model for the agency.

Mission Issue

Reclamation will benefit from increased economic analyses of the design and maintenance decisions made for its corrosion control. This will result in lower costs to protect Reclamation's steel infrastructure. The research also reveals a compelling opportunity to develop a model for forecasting Reclamation's corrosion protection costs.

Principal Investigator

Bobbi Jo Merten
Coatings Specialist
Materials and Corrosion Lab
Technical Service Center
bmerten@usbr.gov

Research Office Contact

Erin Foraker
Renewable Energy and Infrastructure Research Coordinator
eforaker@usbr.gov

Bobbi Jo Merten
S&T POC for Water Infrastructure
bmerten@usbr.gov

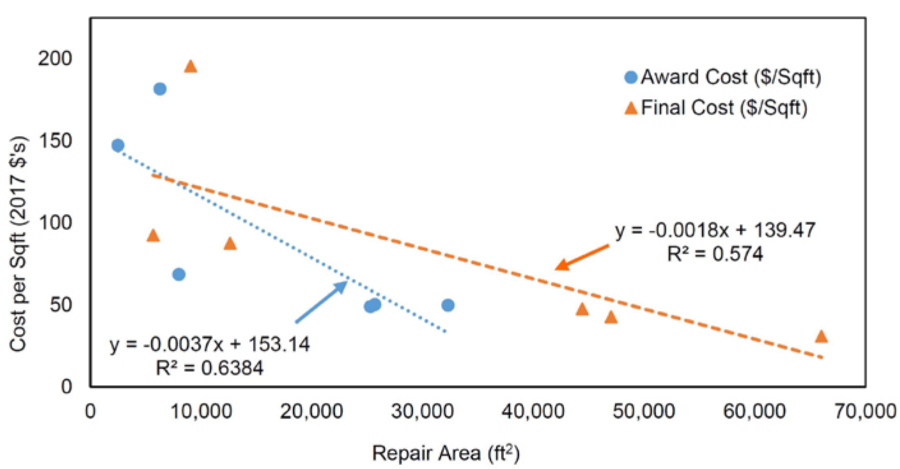
Problem

Corrosion protection is necessary to preserve the integrity and functionality of the Bureau of Reclamation's steel infrastructure. Protective coatings (coatings) and cathodic protection are the available methods for protecting these structures. The original, non-environmentally friendly coatings are being replaced with coatings that have a markedly shorter service life. These shorter service life coatings, combined with increasing construction costs, is resulting in significant increases in coating costs for Reclamation infrastructure. Put another way, the overall cost of corrosion protection to the agency is rising.

Solution

Researchers developed a Microsoft Excel spreadsheet tool and applied it in two case studies: 1) a life-cycle cost analysis of penstock interior coatings and 2) a break-even analysis of cathodic protection (CP) systems on gates. The life-cycle cost analysis spreadsheet tool (LCCAST) can be applied to future construction projects where the cost of alternative options will drive the decision-making. The approach is especially useful for determining whether a higher up-front investment cost will be economically justified by a longer service life. The break-even analysis showed that CP results in a cost savings for protecting steel infrastructure. The case study showed CP to be cost-effective after increasing the coating service life by 15–30%, or 2 to 9 years in this case study.

A preliminary econometrics framework and initial dataset suggested a negative correlation between coating cost per square foot and total surface area being recoated (figure below).



Regression analysis for awarded and final contract repair area versus cost.

"Reclamation has built some of the world's most impressive water infrastructure, but the substantial cost of corrosion protection for this aging fleet is often overlooked and underestimated. This research project develops an economic framework and set of tools to assist facility managers in making the most cost-effective corrosion protection choices, leading to significant savings for stakeholders and the nation."

Todd Gaston
Economist
Reclamation

Collaborators

Lonnie Zlomke
Technical Service Center

Nathaniel Gee and George Wendt
Boulder City, NV

Jesus Alvarado
Yuma, AZ.

More Information

https://www.usbr.gov/research/projects/detail.cfm?id=4724

https://www.usbr.gov/research/projects/researcher.cfm?id=2334

Application and Results

Case Study #1 assessed the life-cycle costs of competing coatings for penstock interiors. The LCCAST performed the theoretical evaluation of two coating systems. The outcomes are reported as the annualized cost. The option providing the lower annualized cost is the more cost-effective alternative.

Case Study #2 evaluated the cost effectiveness of a CP system in terms of their tendency to extend the usable service life of the coating. Researchers modified the LCCAST for a break-even analysis to determine when the CP system investment results in lower annualized costs compared to the coating alone. At this break-even point, the CP system has paid for itself through the costs saved by delaying the recoating work. See figure below.

Case Study #3 developed a preliminary econometrics framework to better understand corrosion protection cost trends. Econometrics employs a large dataset to derive statistically significant cost trends and relationships between variables impacting costs. Initial outcomes suggest a strong negative correlation between coating cost per square foot and total surface area being recoated.

Project: Parker Dam Penstock Gates Recoating Analysis

Basic LCC assumptions	
Index year	2016
Study period (LCM of A1 LC and A2/3 LC)	150
Discount rate	2.875%

Payback Period (years)	5

	A1		A2		A3	
	Min # of life-cycles:	1	Min # of life-cycles:	1	Min # of life-cycles:	1
Item #	Description	Timing of cost	Description	Timing of cost	Description	Timing of cost
ICC-1	Recoating	25	Recoating	30	Recoating	30
ICC-2			Install GACP	30	Install ICCP	40
ICC-3			Inspection/Design	30	Inspection/Design	30
PMC-1	Spot repair	17	CP Replacement	20	CP Replacement	20
PMC-2			Spot Repair	20	Spot Repair	20
AMC-1	Annual Inspection	1	Inspection/Design	1	Inspection/Design	1
PV over study period		$6,742,819		$6,999,632		$6,615,216
PV over relining LC		$3,472,597		$4,091,031		$5,350,582
EUAC		$196,657		$204,147		$192,935
		Savings vs. Alt. 1 =	-$256,813 over 150 years		$127,602 over 150 years	
		or	-$7,490 annually		$3,722 annually	

Screenshot of life-cycle cost analysis spreadsheet tool summary output showing functional input variables and results.

Future Plans

Further case studies could be run using the spreadsheet tools developed in this study for ground truthing purposes and to contribute to Reclamation's cost planning knowledgebase.

Econometrics should be applied to a larger dataset of completed and planned coatings projects to derive statistically significant cost trends and relationships between variables impacting costs. The outcomes can then be developed into a model for forecasting Reclamation's corrosion protection costs.