RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Evaluation of Field Repairable Materials and Techniques for Cavitation Damage

Developing a test method to evaluate materials for cavitation resistance

Research Bulletin
Science and Technology Program

S&T Project 8452

By using an accelerated cavitation testing method with field-representative specimens and test conditions, Reclamation will be able to assess and characterize the cavitation resistance of various coatings and thermal spray application techniques.

Mission Issue

Improved cavitation testing techniques will refine the assessment and selection of cavitation-resistant materials and help mitigate the expensive problem of cavitation damage on Reclamation's hydropower components, pipes, and outlet works.

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Problem

The Bureau of Reclamation utilizes hydraulic structures to generate power and collect, convey, and store water. As a result of the hydraulic conditions within these structures, many of them, such as hydro-turbines, can be subject to extensive damage from cavitation. Currently, Reclamation's primary method for mitigating cavitation on hydro-turbines is the use of stainless-steel weld overlays. However, this procedure is time-consuming and expensive, costing $100k -$250k per each unit repair, every 1-3 years. This estimate does not include lost revenue due to unit downtime, which can be even more costly.

Solution

This project work focused on establishing a viable test method with specimen sizes that were representative of field conditions, as well as test durations that were feasible to perform in the lab. Researchers investigated three test apparatuses: an ASTM G134 rig, a 1960s Reclamation-designed venturi facility, and a submerged jet cavitation/erosion apparatus. Ultimately, researchers found that the submerged jet apparatus was the most representative and viable test method to use moving forward.

Turbine runner damage from cavitation (left) Upper Molina powerplant and (right) Flaming Gorge powerplant.

Submerged jet testing apparatus.

"Cavitation is an expensive problem. Material options need to be tested in terms of their cavitation resistance. Having this type of testing in Reclamation's repertoire will be highly advantageous and provide a significant cost savings."

Chrissy Henderson
Materials Engineer
Bureau of Reclamation

Collaborators

Pacific Northwest National Labs

Extreme Coatings, LLC

More Information

https://www.usbr.gov/research/projects/detail.cfm?id=8452

Application and Results

Using the submerged jet apparatus, researchers tested three specimens: bare stainless steel, cold-spray-coated, and thermal-spray-coated. It was found that the testing conditions were too aggressive for the specimens, and that further optimization of the test set-up will need to occur prior to further testing. Under the aggressive testing conditions, the stainless steel specimen outperformed the cold spray and thermal spray specimens, with the thermal spray specimen performing the worst. However, results were inconclusive due to the testing conditions, and future work is required to obtain valid results.

Future Plans

Submerged jet testing parameters will be optimized to create a less aggressive environment. With the optimized test, the submerged jet method will be used for cavitation testing of many other specimen types: protective coatings, additional cold spray and thermal spray specimens with various application parameters and methods, and solid materials used in other industries (e.g. naval bronze).

Cold spray specimen with crack, due to aggressive testing parameters.