

## Research Update

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### Bottom Line

The Materials and Corrosion Laboratory in Reclamation's Technical Service Center conducted a study to determine if magnetic nondestructive testing (NDT) could reliably and accurately predict the structural condition and, ultimately, the remaining service life on wire hoist ropes.

### Better, Faster, Cheaper

This method could be used to test ropes without taking the gate out of service or permanently damaging the ropes. NDT could help determine when to remove wire hoist ropes from commission and decrease the frequency of possible unnecessary replacements, significantly decreasing costs over time while ensuring safety.

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## Service Life Determination of Wire Hoist Ropes Using Nondestructive Testing

*Investigating the magnetic nondestructive testing (NDT) method to predict the remaining service life of wire hoist ropes*

### Problem

Many of Reclamation's wire hoist ropes for operating gates are approaching the end of their expected life cycle. In accordance with American National Standards Institute B77.1 and U.S. Code of Federal Regulations 30 CFR 30, ropes require replacement for a certain amount of corrosion on the surface or where corrosion has caused a given number of broken wires. In addition, the regulation suggests the useful life of a wire hoist rope is only 15 to 20 years. However, simply looking at a wire hoist rope does not provide enough information to determine whether they are still serviceable and safe.

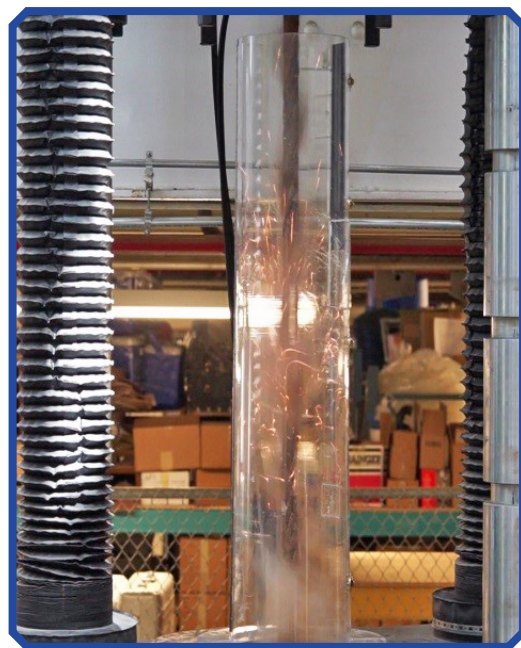
Nondestructive testing (NDT) is a more effective and accurate way to determine if wire hoist ropes are still suitable for use. For example, while wire hoist ropes for some of the gates on the Shasta Dam Temperature Control Device in California showed corrosion on the surface during a routine visual inspection, magnetic NDT showed that these ropes were still within the acceptable factor of safety. Thus, using NDT could aid in preventing premature replacement of ropes, thereby extending the usable life of the ropes and reducing capital expenditure. Moreover, Reclamation could improve dam safety by using NDT to examine wire hoist ropes for personnel elevators, gate hoists, and various cranes throughout Reclamation.

### Solution

This Reclamation Science and Technology Program research project evaluated the magnetic NDT method by testing sections of wire hoist ropes exposed to multiple exposure conditions including air, full immersion in water, and fluctuating immersion. Magnetic NDT was conducted on the rope sections to determine the condition of the wire hoist ropes and identify problems or weak areas, such as broken wires.

Destructive testing of the rope sections were then performed on a new wire hoist rope from Silver State Wire Rope, along with two corroded sections of wire hoist ropes from the Shasta Dam Temperature Control Device. The test specimens were fitted with splter sockets on both ends and underwent tensile testing until failure.

Magnetic NDT results were compared with the tensile test results for the old and new wire hoist ropes to identify the condition of the old corroded wire hoist ropes. This was used to determine the usefulness of magnetic NDT.



*Sparks from individual strand breaks during tensile test.*

## Application and Results

During the magnetic NDT testing of the Shasta Dam Temperature Control Device wire hoist ropes in 2009, inspections showed that the ropes' condition varied along the length of the ropes. The wire hoist ropes were replaced 2 years later as recommended by accepted practices. This research project tested the old wire hoist ropes to help verify the NDT testing results and physical strength of some rope sections. The wire hoist ropes were sent to Silver State Wire Rope in 2012 to re-test short sections of the ropes, which showed varying degrees of damage. However, results were inconclusive as the test sections used were too short and the data were noisy and hard to interpret. Because there is such large variability along the length of a full rope, short sections are not representative of the condition of the full rope. Moreover, the ropes were very far along in the degradation process.

Magnetic NDT suggested that the wire hoist ropes, when measured in 2009, still were within a reasonable safety factor, but did not contain any comparable data to a new wire hoist rope. Tensile tests compared two of the corroded wire hoist ropes with a new wire hoist rope. The measured maximum tensile strength of the new wire hoist rope was 300,000 pound force (lbf) compared to the two corroded wire hoist ropes, which were over 175,000 lbf. The corroded ropes failed as individual strands broke, rather than failing by unwinding. A typical design safety factor is 5:1 for wire hoist ropes. Even the most corroded rope achieved a safety factor of 3.5:1, which is still acceptable. This assumes an in-service working load of 30,000 pounds for each of the wire hoist ropes, based on calculations under normal balanced lifting. A loss in strength of 10 percent is assumed due to bending of the ropes at the drums/sheaves. Researchers were unable to establish a strong correlation between the tensile test results and the magnetic NDT results.

## Future Plans

This research project demonstrated that NDT testing is a valuable accompaniment to visual inspection to gauge the condition of the interior, non-visible regions of a wire hoist rope. Magnetic NDT testing would be more effective if testing occurred at regular intervals and started at the beginning of a rope's life. Therefore, more assessments using newer ropes are required to ascertain the feasibility of the magnetic NDT method.

Inspecting wire hoist ropes using NDT methods could help extend their service life and ensure safety of operation, thus potentially saving millions of dollars on Reclamation projects by extending the time between replacements.



*Magnetic NDT device used for determining condition of corroded wire hoist ropes.*

***“NDT can help determine when to remove wire hoist ropes from service and decrease the frequency of possible unnecessary replacements, significantly decreasing costs over time while maintaining safety requirements.”***

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## More Information

[www.usbr.gov/research/projects/detail.cfm?id=3973](http://www.usbr.gov/research/projects/detail.cfm?id=3973)