



**US Army Corps  
of Engineers®**

Engineer Research and  
Development Center

# Navigation Systems Research Program

## Nondestructive Condition Monitoring for Tensioned Steel Members

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**Problem** The Corps of Engineers maintains many structures that have embedded and external steel structural members which are under tension and subject to corrosion. Tainter gates and lock gate diagonal bracing are two examples. Tainter gates are restrained using trunnion bearings held in place by massive steel anchors embedded into the dam. Problems known to occur with anchors can lead to loss of anchor tension and consequent severe problems with gate operation. Because these anchors are embedded, problems are hidden and difficult to evaluate.

Problems with current testing methods are insufficient accuracy, long test times requirements, and limited access. A non-destructive testing (NDT) method is needed to determine the tension and the degree of corrosion present. A method to continually monitor the tension while opening and closing the gates could prevent abrupt failures of the rods.

**Research Approach** This project involves both laboratory development and field testing. The laboratory studies include several components. First we developed the required theory and mathematical models to predict tension and degree of corrosion based upon propagation anomalies in acoustic signals due to material/corrosion product/acoustic interaction. Next we expanded the theoretical basis for optimal wave shapes to produce the greatest signal change when the acoustic wave interacts with the material and corrosion products. We will develop sensor designs to generate and detect low frequency shear waves. These designs will be guided by consultations with commercial acoustic sensor manufacturers. Advanced acoustic coupling methods will permit launching and receiving low frequency sound directly into concrete or buried metallic elements.

**Labs/others involved** ERDC-CERL, Carlyle Consulting

**Final Products** This technology will be used to conduct quantitative measurements of tension and corrosion in steel tainter gate anchor rods and lock gate diagonal bracing. The instrument will rapidly measure tension in the field and, with post-processing, will provide evaluation of fitness for service. The equipment it will be small, portable and will work in areas with limited access.

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