Condition Assessment Procedures for Concrete Dams with Post-Tensioned Anchors

Situational Awareness

Many concrete dams during the last 30 years were retrofitted with post tension strands tying the dam to an anchor point, usually in the rock foundation. The question of fully grouted versus re-tensionable anchors is currently an unresolved issue within the industry. Researchers at the US Army Engineer Research and Development Center (ERDC) are looking to develop engineering procedures to estimate the current state of load-carrying capacity of the ground anchorage, remaining life of the tendon, and the deterioration or relaxation of anchorage capacity (with time). More work is needed to fully understand the benefits and limitations associated with these techniques. The advantage that is sought with re-tensionable anchors is the ability to periodically test the anchor tension and, if necessary, re-tension the anchors. The disadvantage is the potential for more corrosion of the anchor strands and the anchorage head. The current thinking within the USSD Concrete Dam Committee is that the most prevalent problem with re-tensionable anchors is corrosion of the anchorage head, which reportedly is quite common.

Recently, research has been conducted for using Performance Based Testing (PBT) for evaluating the condition of anchors in concrete dams. The research procedure relies on the dam's ability to "pluck" the anchors into resonance. Conceptually, this may confuse some engineers since the typical post-tensioned anchor is designed using basic equilibrium (static) equations, and is never considered to be a dynamic component in the dam. However, the research procedure recognizes that all components - including the dams themselves - are dynamic components, and it is left to the engineer to identify the frequency ranges within which these components "come alive." To that end, the anchors installed in a monolith are mostly dormant, and would not be considered as active unless the design loads are approached or exceeded. However, using the PBT techniques provides the ability to introduce vibrations into the dam that produce transient responses with frequency content that is broad enough to include both the dam and the anchor behavior. The technique for separating the dam and anchor responses rests with the use of a model that focuses on the anchor and that can be used to extract the desired behavior.

Project Overview

This project relies on an innovative technique that engages the entire dam in the evaluation of the anchors and of their condition. The technique employs the use of a device that delivers a short duration, impulse load to the dam and that contains enough energy to excite the anchors and the dam's monoliths into measurable dynamic response. Spectral analysis techniques are used to separate anchor and monolith responses, and an analytical model of the anchor is used to develop an Anchor Condition Indicator (ACI) that is used to evaluate the in-situ condition of the anchor.

Next Steps

The project team will make improvements to an existing post-tension anchor tension model, investigate the importance of vertical anchor response measurements to the determination of tension load in a post-tensioned anchor, and develop an analytical model to add the vertical response of the anchor if the vertical response is determined to be important for determining the load in a post-tensioned anchor.

They will then do further validation of the process by evaluating an additional 4 anchors, developing a defined process of anchor testing by identifying precise position of accelerometers, location of excitation device, desired peak load levels, and specifications for the accelerometers, developing a process for determining a baseline condition of a post-tensioned concrete dam, and implementing a "test point" approach in which a select number of (discrete) test points or locations in the dam are used to characterize the dam's existing condition. Furthermore, the team plans on conducting performance based testing of some individual post-tensioned monoliths in at least one of the dam's 6 sections.

To learn more about this project, contact
Jay Robinson, DHS Program Manager, at jay.robinson@hq.dhs.gov or
John Taylor, CEO, NIHS at jdtaylor@thenihs.org

2018-12.1pager