RECLAMATION *Managing Water in the West*

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The Knowledge Stream

Research Update

Testing and Verifying Rope Access Anchors

Making sure concrete anchor bolts perform safely for rope access technicians

Bottom Line

This research tested concrete anchor bolts and identified and verified "best practices" for their use in the field.

Better, Faster, Cheaper

Providing general guidelines to aid the experienced rope access technician to more effectively build safe anchor systems. Investigating safe anchor systems improves Reclamation's ability to conduct safe rope access work on its aging infrastructure.

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Problem

Workers use rope access to access structures, geologic features, or other inaccessible locations that cannot be accessed by "normal" means. These rope access technicians pin their lives on these ropes as the primary means of support, positioning, and safety protection to ascend, descend, and traverse a location while suspended in a specially designed harness.

Ropes are anchored to a surface and must support the worker, weight of the rope, and anything attached to the rope. The Occupational Safety & Health Administration (OSHA) mandates that life safety anchors must be capable of supporting a 5,000-pound (lb) static load (OSHA CFR 1926.502).

Concrete anchor bolt while holding the OSHA weight limit (5,000-lb static load).

Reclamation personnel frequently use a variety of anchor types, and often use anchor bolts installed in concrete or rock. Using these anchors safely relies on the experience and judgment of a rope access technician for proper assembly and installation. Concrete anchor bolts have been studied extensively, but still they are one of the most mysterious forms of anchoring and, therefore, contain a certain amount of risk. The strength and condition of the concrete at Reclamation's aging structures are unknown. Moreover, there are no general guidelines to preparing and using these anchors, so verifying that the anchor bolts are installed correctly can also be difficult.

Epoxy anchor bolt failure by pulling out of its hole until the concrete shear cone ruptures.

Solution and Results

This Reclamation Science and Technology Program research project investigated the various anchors Reclamation's Rope Access Team use. To mitigate the risk of uncertainty in the substrate and to verify the installation of the anchor, proof load tests were conducted to evaluate an anchor bolt before it is put into use. Criteria were also developed for the acceptable use of anchor bolts.

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Two categories of concrete anchor bolts were tested: adhesive-type anchors and mechanical-type anchors. Each type of system has distinct advantages and disadvantages and was expected to be susceptible to different installation errors. Furthermore, both types of systems are commonly used at Reclamation and, therefore, merited testing. To simulate potentially common installation mistakes that might be expected during field installations, various installation defects were tested. To simulate relatively weak and stronger concrete, two concrete mix designs were used. Results showed that:

- Pull testing ½-inch Powers, Hilti Kwik, and Redhead bolts to 5,000 lbs had little or no effect on the performance of the bolts. Therefore, proof load testing to relatively low loads of 1,100 lbs (approximately 5 kilonewtons) as recommended by Reclamation rope access guidelines seems unlikely to weaken the anchors.
- Many of the anchor configurations tested were not strong enough to meet the 5,000-lb static load requirement specified by OSHA and the Society of Professional Rope Access Technicians (SPRAT) guidelines. When using these configurations, anchors should always be used in load-sharing pairs that achieve the minimum requirement of 5,000 lbs. Great care should be taken with load-sharing anchor bolts with less than a 5,000-lb strength. Due to the angle of pull on load-sharing bolts, two 4,000-lb anchor bolts may add up to be less than a 5,000-lb anchorage.
- Even if an anchor meets the 5,000-lb requirement, the failure mechanism may provide an added measure of safety if it fails gradually by pulling out of its hole instead of failing catastrophically (i.e., bolt fracture).

The final report provides details on anchor configurations and specific recommendations for using concrete anchor bolts for rope access at Reclamation's facilities. These findings will be incorporated into the *Reclamation Rope Access Guidelines Manual* (soon to be renamed "Bureau of Reclamation Rope Access Safe Practices").

Future Plans

Reclamation's Rope Access Team continues to work on testing safety equipment to help improve safety standards. Further testing needs include:

- Testing concrete anchor bolts for other defects and to produce additional data points for determination of statistical significance, or to evaluate other types of anchor bolts as they enter the market.
- Researching existing structural supports (such as I-beams) to obtain specific examples of various configurations currently employed within Reclamation's Rope Access Team.
- Testing more configurations of vehicle anchors and developing Lock-Out, Tag-Out procedures to ensure the vehicle is properly protected against any kind of tampering. Test procedures should also be created to dynamically test vehicles as anchors using drop tests based on the preliminary static testing of vehicles as anchors.

"This research into life safety anchors helps Reclamation continue to develop safe practices and protocols for rope access maintenance and inspection of inaccessible features on Reclamation structures."

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More information

www.usbr.gov/research/projects/detail.cfm?id=6390

Anchor testing configuration. A hydraulically actuated ram is connected through a clevis rod and quick linked to the anchor. Threaded rods provide height and level adjustment.