

Experimental Investigation of Post-Tensioned Anchored Trunnion Rods of Navigation Structures

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ABSTRACT

The United States Army Corps of Engineers employ Tainter gates to effectively regulate water flow through dam spillways from upstream to downstream of navigation locks and dams. Post-tensioned Tainter gate anchorages are widely utilized in numerous dams across the United States, predominantly within the Mississippi Valley, Great Lakes and Rivers, Southwestern, and Northwestern Divisions. Ten dams were tested between 2010 and 2017, and failed rods were found on eight of these dams. Testing 5,371 greased trunnion anchor rods showed that 22 rods were broken, and 6 rods had slipped gripping hardware. In addition, 202 rods on Markland Dam and 76 rods on Greenup Dam experienced significant cantilever bending or corrosion, which may contribute to anchor rod failure. The objective of this study is to establish the effect of a failed rod, or rods, on the monitored stress for the remaining rods and on the capacity of the rod groups located in the same box. A comprehensive experimental study was conducted for post-tensioned anchorages with varying effective rod configurations. A scaled anchorage system that includes a post-tensioned concrete trunnion girder with nine high-strength post-tensioning rods was employed in the experimental investigation. Finite element analyses duplicating various trunnion rod failure scenarios were validated using data observed from the extensive experimental investigation. The analytical results accurately predicted load changes of the rods under different loads and de-tensioning configurations. The findings of this study provide a valuable insight that would assist dam owners plan for appropriate proactive maintenance and remediation strategies for post-tensioned Tainter gate anchorages of navigation dam and lock assets.