EXTENDING SERVICE LIFE THROUGH INNOVATIVE ENGINEERING, TESTING, AND INSPECTIONS

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Buchanan Dam is a concrete multiple-arch dam completed in 1938 for water storage and power generation. The dam creates Lake Buchanan, one of the six Highland Lakes on the Colorado River in Texas owned by the Lower Colorado River Authority (LCRA). The dam stretches more than two miles and is one of the largest multiple-arch dams in the nation. The dam includes two multiple-arch sections with 35-foot and 70-foot diameter arches. The arches are supported by buttresses with large corbels at the connection between the arch and buttress. The dam also consists of a powerhouse, gated spillways, an uncontrolled spillway, and embankments.

As part of a comprehensive facility review, structural analyses of the arch sections were performed. As often occurs when re-analyzing old structures using current criteria, some results were unsatisfactory. The corbels were found inadequate in both strength and ductility with brittle failure being a concern. A risk assessment indicated the need for action to address the structural inadequacy. Expenditure for enhancing corbel capacity was estimated between $15 and $30 million.

LCRA engaged Freese and Nichols, Inc. to perform in-depth evaluations before proceeding with such significant construction expenditures. The corbels were first reevaluated using American Concrete Institute (ACI) methodology. Due to differences between the ACI code provisions and the corbel geometry and reinforcement, these results were deemed inconclusive. As a result, 2-D finite element models were developed; however, the adequacy of the corbels could not be substantiated without additional information.

A structural physical model study was implemented at the University of Texas to evaluate the potential failure mechanisms and strength capacity of the corbels. The study consisted of constructing and testing to failure two representative corbel sections instrumented with strain gages and load cells. The tests indicated that shear failure was unlikely. Failure was due to tensile cracking of the concrete section followed by ductile yielding of the reinforcement at the face of the corbel. Results of the physical tests were then used to develop refined analytical models replicating the corbel’s geometry, loads, and material properties. The analytical models found the corbel’s had adequate strength to resist anticipated loads.

Non-structural approaches were also performed. Inspections of the corbels through visual observations and underwater video found no visible signs of cracking that would suggest overstressing or possible failure. Ultimately, the corbel was deemed safe, thereby extending its service life and avoiding a large expenditure on an aging dam through innovative engineering.