RESEARCH PAYS OFF

US Army Corps of Engineers

MODEL SOLUTIONS

Mississippi River Traffic Jam Eased by Use of Model Research

The importance of inland waterway travel to the United States has been recognized since frontier days. The Mississippi River navigation system, the largest inland waterway system in the country, provides one of the safest and most economical means of transporting bulk cargoes. The U.S. Army Corps of Engineers maintains a navigable channel in the river through dredging and a system of locks, dams, dikes, and other structures. The Corps is also responsible for keeping barge traffic moving and unclogging bottlenecks that hamper the flow of river traffic.

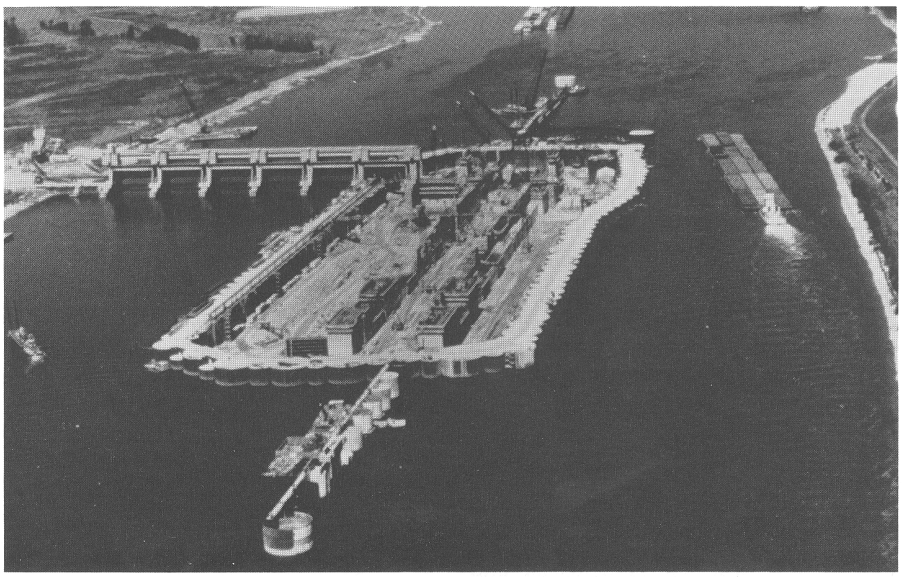
Problem

One such barge traffic bottleneck builds up at Lock and Dam (L&D) 26 (now named the Melvin Price locks and dam), just north of St. Louis at Alton, Illinois. Opened in 1938, L&D 26 has two small locks, 600 by 110 feet and 360 by 110 feet. These gated enclosures are used so that the level of water can be changed to raise or lower boats from one level to another. L&D 26 is the first lock structure that carries the combined waterway traffic of the Mississippi and Illinois rivers.

Originally designed to handle about 46 million tons of traffic annually, L&D 26 must now deal with some 70 million tons of traffic a year. With increased shipping demand and the development of more powerful towboats and larger barges, two- to three-day delays are not uncommon as tows are split up to be locked through in sections and then reassembled.

Solution

To alleviate problems caused by this increase in traffic and provide efficient service for current and future barge traffic, Congress authorized the enlargement of L&D 26. The Corps' St. Louis District was assigned responsibility for the project.



Looking upstream, Lock & Dam 26 under construction.

Faced with the size and complexity of the L&D 26 project, St. Louis District officials asked the U.S. Army Engineer Waterways Experiment Station's (WES) Hydraulics Laboratory to undertake a comprehensive model research study.

The WES model was used to determine the best location and arrangement of the locks, lock walls, and dam. The model also provided the flow conditions in the upper and lower lock approaches for various river flows and lock and dam arrangements. During the course of the project, the model was also used to determine navigation conditions during construction of the structure, modifications to construction phases or river traffic restrictions to maintain two-way navigation, and effects of the new structure on flood stages.

Completed in 1966, the WES L&D 26 model is a 1:120-scale model that reproduces a 6.7-mile reach of the Mississippi River (see photograph this page). It provides accurate reproductions of stages, velocities, cross currents, eddies, and other effects of navigation in the project area. Two different remotecontrolled model towboats have been used to determine the effects of various river currents on tows entering and leaving the locks.

Model studies addressed not only possible modifications of the existing L&D 26 structure but also construction of replacement structures. On the basis of input from the model, it was decided that it would be better for navigation and for structural integrity to construct a new lock structure two miles downstream from the existing L&D 26.

Application

The plan chosen featured two separated locks, one 110 by 1,200 feet and the other 110 by 600 feet, located on the Illinois side of the river. One innovative recommendation from the model study was to separate the two locks by placing two of the 110 by 600-foot-wide spillway gates between them. This suggestion was adopted and will allow simultaneous two-way navigation. The large lock will allow 15 jumbo barges and a towboat to lock through, with a maximum lift of 24 feet.

Construction on the $965 million project began in late 1979. Until project completion, set for late 1992, the WES model will continue to provide answers for the L&D 26 project.

In addition to the navigation studies, WES has provided input on cofferdam placement, size, and protection during construction and on scouring potential below the cofferdam flood gates. A special 1:24-scale model was developed specifically to address and help prevent costly interior damage to the construction within the cofferdams if flood gates had to be opened during high river stages.

During the October 1986 high-water river stage, the second-stage cofferdams were flooded using the flood gate and interior protection plan developed at WES. This allowed the cofferdams to be deliberately and safely flooded to prevent overtopping and possible collapse while minimizing interior damage.

WES has also provided savings to the L&D 26 project through computeraided engineering. The WES Information Technology Laboratory, working with Virginia Polytechnic Institute and State University, used state-of-the-art finite element analysis along with instrumentation to check the design requirements of the first-stage cofferdam. By demonstrating that the conventional design procedures were excessively conservative in the first-stage cofferdam, it was established that cloverleaf cells were not needed in the second stage, resulting in a construction savings of $6 million.

Benefits

Although the cofferdam design savings are easy to document, the enormous benefits generated by the modeling work are much harder to quantify. Second-stage cofferdam tests conducted on the navigation model resulted in the development of a construction sequence that was completed eight to nine months faster than originally envisioned. Emergency procedures, developed with WES assistance, prevented several million dollars' worth of damage that would have occurred had the cofferdam been overtopped. Most important, the modeling work undoubtedly helped to avoid costly mistakes in the location and construction of L&D 26.

Time-lapse photograph of model towboat leaving Lock & Dam 26 model.

The construction plan provided through the model research has proved successful in a number of ways. First, it has allowed all phases of construction to run smoothly with minimum effects on river navigation. Second, the St. Louis District and WES have gained valuable experience in the design and construction of such structures, using a host of new techniques and concepts. Finally, the WES L&D 26 model will continue to offer practical solutions to problems faced throughout the completion of the new L&D 26 project.

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Suggestions for "Research Pays Off" articles are welcome.

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