CHAPTER 8

REPAIR AND REHABILITATION

8-1. General. Navigation dams will require major repairs, complete rehabilitation, or replacement when normal maintenance becomes excessive or structural integrity is threatened. Repair or rehabilitation is generally less expensive than replacement except where there are major structural stability problems. Specific repair and rehabilitation methods are presented in the REMR notebook (item 27).

8-2. Design Life. The major rehabilitation goal is to extend the useful life of the project for 50 years. When a 50-year design life is not possible, a shorter design life can be recommended with suitable justification. Al though the design life of most projects is 50 years, the practical usable life is much longer.

8-3. Modernization Features. Modernization items should be considered in any rehabilitation plan. These items are intended to make the structure comparable to a state-of-the-art replacement. Modernization items will be evaluated based on faster operating time, safety, reliability, and reduced manpower needs. Modernization items can include the following:

a. Modern machinery.

b. Modern electrical equipment.

c. Remote controls.

d. Television surveillance system including audio in some instances.

e. Emergency closure.

f. Adding gates to ungated spillways.

8-4. Typical Repair and Rehabilitation Items. The following are common items for major navigation dam rehabilitation projects:

a. Dam Stability.

(1) Replace upstream and downstream scour protection.

(2) Tendons through structure into foundation.

(3) Cutoff of dam underseepage.

b. Discharge Capacity.

(1) Additional gates.

(2) Overflow dikes.

(3) Raise dam.

c. Ice and Debris Control.

(1) Submerged gates.

(2) Control booms.

(3) Air screens.

(4) Gate heaters.

d. Replacement in Kind.

(1) Resurface concrete surfaces.

(2) Repair or replace gates.

(3) Fix gate anchorages.

(4) Replace embedded metal.

(5) Electrical and mechanical equipment.

8-5. Scour Protection.

a. Background. Inspections of the Corps of Engineers navigation dams (over 200) often show large scour holes downstream from the stilling basin. At some projects, the scour hole had undercut the stilling basin foundation to a point where remedial work was necessary. These scour holes are often caused by single gate operation to pass drift or ice during low tailwater conditions. Single gate operation produces jet flow that is constricted and intensified by return eddy currents in the stilling basin. Guidance for evaluation of major rehabilitation of existing projects follows.

b. Existing Project Design. Repair of existing projects requires evaluation of the same conditions listed in paragraph 8-4. However, remedial work is usually directed to the downstream protection because of the high cost of enlarging existing stilling basins. Design life of the remedial work can be based on judgment of how the original project performed. Hydraulic model studies are usually needed to verify the final design.

c. Consequence of Failure. An analysis of the consequences include repair and replacement costs and lost navigation benefits as well as loss of life and property. Very conservative design conditions are usually selected for a project on a busy waterway with sizable downstream population.

d. Design Rationale. This guidance must be site-adapted to specific project conditions. The design engineer is responsible for developing a safe, efficient, reliable, and least-cost plan with adequate consideration of environmental and social impacts. Design innovations based upon sound judgment that are well documented are encouraged.

e. Fixed-Crest Dams. Scour downstream from fixed-crest dams is often caused by high velocity and excessive turbulence exiting the spillway apron. Modifications to the existing dam are often required before a suitable scour protection plan can be implemented. If there is evidence of piping of underlying materials through the stone protection, the cause may be fluctuating pressures or excessive ground water pressure. The repair should consider appropriate filters.

f. Gated Structures. Gated structures usually have a stilling basin that dissipates energy adequately when the project operation schedule is not violated. Scour downstream from these structures is usually caused when the structure is misoperated due to ice or debris passage and occasionally navigation accidents. A typical example would be a single gate that is raised higher than the operation schedule allows in order to pass ice through the structure. Generally during periods when ice passage is required, the tailwater is very low or at minimum elevation. The increased discharge due to the gate being raised higher than normal and the low tailwater cause significant turbulence in the downstream channel oftentimes resulting in severe scour and failure of the stone protection. Another flow condition that causes scour downstream from a gated structure is an undulating jet. This occurs when high tailwaters force the flow entering the basin to undulate and ride the surface of the tailwater through the basin and then plunge through the tailwater after leaving the basin. The plunging jet oftentimes is strong enough to reach the streambed or the stone protection and cause scour.

g. Methods of Protection. Some Corps districts have already begun to repair the scoured areas below navigation dams using graded stone protection and grout-filled bags. Site-specific model studies are oftentimes used to select an appropriate scour protection plan. Graded stone protection has been used by the St. Paul District on many of their navigation projects located on the upper Mississippi River. Model studies on some of these projects revealed that if the existing scour holes were armored with a large graded stone the structure could be protected. Grout-filled bags were used by the Pittsburgh District at Emsworth Dam on the Ohio River. The bags were used as an emergency replacement for large rock that probably failed during ice passage. Sunken barges filled with grouted rock are being considered for scour repair at Dam 2 on the Arkansas River. This repair method has the advantage of being able to be placed in the wet.

8-6. Repair and Rehabilitation Model Studies. The following model studies for major rehabilitation have been conducted by WES to address repairs to scour protection:

Project	Feature	Problem	Recommendation
Arkansas River Dams	Spillway gates	Gate vibrations	Remove seals on the bottom of gates. Projects requiring bottom gate seals should use Type D in Figure 5-19

Project	Feature	Problem	Recommendation
Cheatham Dam	Spillway gates	Modify partially submergible gates to lift gates	Retain original gates and modify the sill and trajectory (Add 1.2 feet to sill elevation and an $x^2 = 26.8y$ trajectcry over the original 1-on-1 slope)
Upper Miss. River Locks No. 2-10	Scour repair downstream Stilling basin Gated structures	Excessive scour during past forty years of operation	Provide additional scour protection by underwater placement of quarrystone and graded riprap as determined in model tests
Montgomery Dam, Ohio River	Scow repair down-stream Stilling basin Gated structure	Excessive scour	Provide better toe protection and filter
Emsworth Dam, Ohio River	Scour repair downstream Stilling basin Gated structure	Excessive scour	Provide protection with large riprap or grout-filled begs
Allegheny, Ohio, and Monongahela Rivers	Scour downstream from stilling basin or structure Uncontrolled structures	Excessive scour	Provide protection with large riprap, grout-filled bags, sunken barges filled with grouted riprap, and/or modify structure
Dashields	Scour repair Uncontrolled structure	Excessive scour	Provide protection with large riprap and modify stilling basin
Pike Island, Ohio River	Scour repair Gated structure	Excessive saw	Provide protection with large riprap
L&D No. 2 Arkansas River	Scour repair Gated structure	Excessive scour due to barge accident and low tailwater	Sunken barges filled with grouted riprap