REMR Technical Note OM-MS-1.7

REMR Management System for Sector Gates

Purpose

To develop a uniform procedure to describe the current condition of sector gate structures and to develop guidelines for the maintenance and repair of these structures.

Background

The U.S. Army Corps of Engineers has a large inventory of sector lock gates (Figure 1) that were designed and constructed on navigable inland waterways and coastal systems. To aid those involved in planning and budgeting for maintenance and rehabilitation of these aging facilities, a series of REMR Management Systems is being developed. These computerized maintenance management systems help provide a more effective means of monitoring facility condition, and they provide decision support for planning REMR activities through life-cycle cost comparisons of maintenance and repair alternatives. (See REMR Technical Note OM-MS-1.1)

Overview

A REMR Management System has been developed for sector gates. Like previous REMR Management Systems, this one is a collection of standardized condition inspection and rating procedures, life-cycle/cost-analyses routines, and personal computer based database management. The software produces a variety of reports for work planning and budgeting.

Condition Index Rating

As with the other REMR Management Systems, the primary driving element is the condition rating process. The condition ratings follow the standard REMR Condition Index (CI) scale from zero to 100. As described in REMR Technical Note OM-CI-1.2, the CI is used to group structures into three zones. The numbers and zones indicate the relative need to perform REMR work because of deterioration of the functional and structural characteristics of the structure. The CI calculation is based primarily on objective field measurements, with some dependence on subjective observations of problems.

Application of the management system begins with an inspection of a sector gate according to standard procedures. A series of critical measurements are made on each gate. Each measurement is related to at least 1 of the 10 distresses listed in Table 1 by a set of rules established by Corps experts. As an example, a movement, X , of 0.01 ft could be measured for the levelness distress listed in Table 1. If the experts determined the limiting value of this movement, X_{max}, to be 0.02 ft (X/X_{max} = 0.5), Figure 2 would give a condition index near 63. This is a zone 2 condition in which an economic analysis of different repair alternatives is recommended. A similar procedure is used for the other distresses. The condition indexes for the individual distresses are combined by a weighted average to give the overall condition of the gate.

Table 1
Distresses in Sector Gates

Distress	Description
Top anchorage movement	Displacement of embedded anchorage system
Gate deflection	Nose deflection before hinge pin rotates
Levelness	Vertical gate displacement
Cracks	Breaks in structural steel components
Dents	Disfigured structural steel components
Noise, jumping, and vibration	Abnormal noise, jumping, or vibration during gate operation
Corrosion	Loss of steel due to interaction with the environment
Hinge wear	Total wear in hinge pin casting (anchor bracket to hinge bracket)
Vertical wear of thrust bushing	Vertical wear of thrust bushing from reference position
Leaks and boils	Water passing through or around the gate

Structural Considerations

Many factors were taken into account by the experts as they formulated the CI rules. A primary consideration is structural safety. Observations may indicate that the potential for a safety problem exists. These types of observations are difficult to quantify and usually are not accounted for in a simple structural analysis. As an example, excessive movement of the anchorage embedment at the steel and concrete interface may indicate a potential safety problem. Only a more detailed inspection, which may require concrete removal, will reveal the true cause. In addition to the functional factors, the experts took such structural factors into account when setting limiting values, X_{max}, and weight factors.

Some of the distresses in Table 1 have a more significant impact on safety than others. The structural distress subset is listed in Table 2. On the basis of

Table 2
Structural Distresses

Distress	Description
Top anchorage movement	Embedded steel movement
Jumping	Abnormal gate jumping
Girder cracks	Breaks in main horizontal girders
Girder dents	Disfiguration of main horizontal girders
Girder corrosion	Loss of girder steel
Gate deflection	Nose deflection before hinge pin rotates

the experts' judgment, the individual structural distresses are flagged by an asterisk on the CI report as the CI becomes low to alert the engineer that a potential structural problem may exist.

Maintenance and Repair Analysis

After the distresses have been identified, several different maintenance and repair solutions can be formed. The consequences of each solution are obtained by calculating a new CI that reflects the as-repaired structure. Life-cycle cost information about the solution can provide a preliminary evaluation of a maintenance plan. Through comparison of several different solutions, the optimal maintenance and repair solution can be obtained from a given set of parameters.

Reference

Greimann, L., Stecker, J., and Rens, K. (1993). "Condition rating procedures for sector gates," Technical Report REMR-OM-13, U.S. Army Construction Engineering Laboratory, Champaign, IL.

Figure 1. Sector lock gate

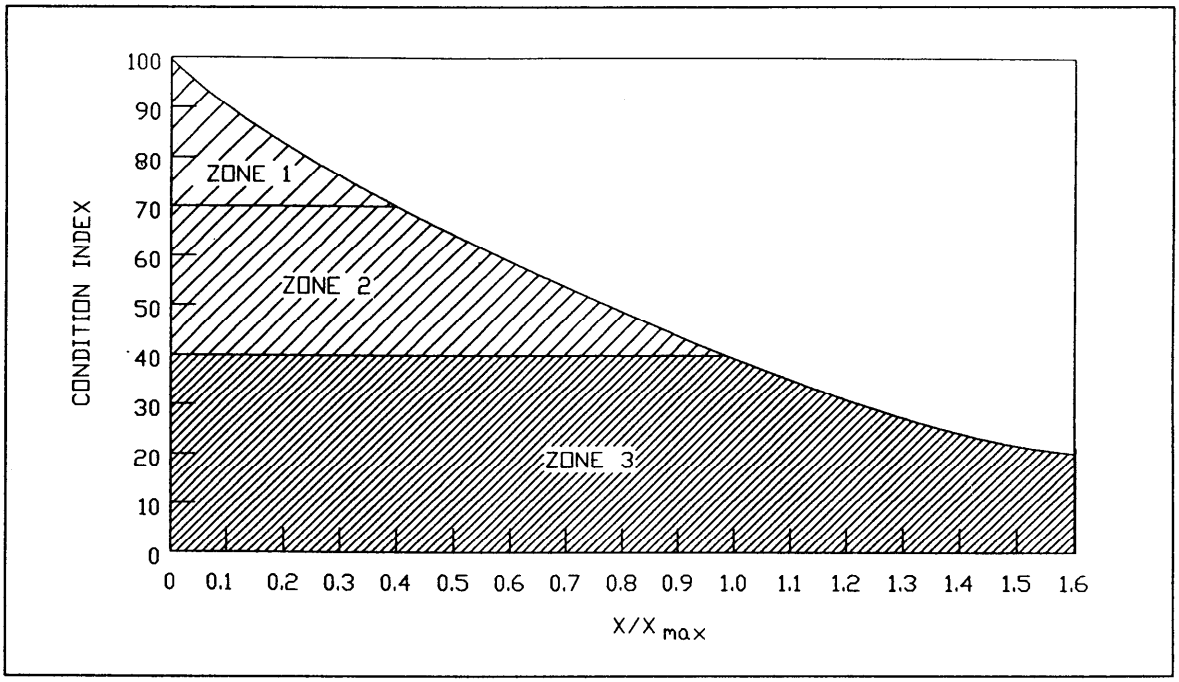

Figure 2. Condition index related to X/X_{max}