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Zebra Mussel Research Technical Notes

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Periodic Inspection at Black Rock Lock — A Review of Procedure

Background and purpose

During periodic inspections of civil works structures, as outlined in Engineer Regulation 1110-2-100 (Headquarters, U.S. Army Corps of Engineers 1988), evidence of concrete deterioration may be recognized, requiring critical examination for remedial action. Evaluation of older structures is required to estimate service life for replacement or rehabilitation. This technical note outlines the difficulties that may be encountered in performing condition surveys where a heavy zebra mussel infestation occurs. Many activities are involved in conducting a condition survey (Stowe and Thornton 1984), but the visual inspection allows estimation of the overall quality of the concrete being investigated.

Additional information

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Inspection procedure

Condition surveys of locks are sometimes associated with scheduled dewatering of the lock chamber, which permits examination of surfaces below the water level or, in cases in which the lock or structure is not dewatered for visual inspection, may be performed underwater by divers or using manned and unmanned underwater vehicles. Only those areas below water level are affected by zebra mussel infestation.

Within each structural component, certain features are examined visually for damage and deterioration. These observations provide the basis for estimating the extent of deterioration of the structural elements, allowing engineers and managers to determine proper maintenance or repair strategies for a given set of distresses.

The Black Rock Lock experience has shown that heavy infestation of zebra mussels can coat the surfaces with a mat of zebra mussels 3 to 4 in. (7 to 10 cm) thick, obscuring the features used to assess the quality of the concrete. Major features, such as large cracks in the monolith joints, will reflect through the mat of zebra mussels. However, cleaning is still required to evaluate the extent of cracking and also the quality of the joint.

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It has been observed that zebra mussels, when in early stages of infestation, tend to colonize first along discontinuities such as cracks, actually making them more apparent. However, as heavy colonization occurs, the colonies coalesce to obscure the feature (especially where small cracks associated with pattern cracking and checking may be of interest).

The attachment of zebra mussels can link together loose debris, to prevent scaled or spalled material from completely separating from the concrete surfaces. In these cases, the presence of zebra mussels may give a false indication of competent concrete. It will be necessary to clean surfaces of the component being investigated for adequate detailed visual inspection. Procedures that can be used to remove zebra mussels from structures are described in Keeney (1987).

Leakage through the lock walls was easily observed at Black Rock Lock when it was dewatered in the winter. The temperature was below freezing, and water leaking through the walls froze to form large deposits.

Observations at Black Rock Lock indicate that corrosion of steel appears to be aggravated by the presence of heavy colonization of zebra mussels. Corrosion products are held close to the steel in the byssal threads zone. During a January 1994 walk-through, it was observed that the corrosion on the steel components was much less than what was observed the previous year. The zebra mussels had been killed by the winter dewatering, and only a single layer of animals was observed this year, in contrast to the matted condition found the previous year.

Areas of abrasion and cavitation will not be colonized by zebra mussels. Concrete examined from Black Rock Lock indicated sound, intact interior concrete. Paste of the surface concrete tended to be eroded, leaving aggregate particles in relief. Byssal threads were attached to the aggregate particles while, at other sites, the byssal threads attached also to the cement paste.

It is believed that an anaerobic condition is established by the presence of the thick mats of zebra mussels colonizing the surfaces or even beneath the attachment plates connecting byssal threads to substrate. This decay of organic matter at the interface provides an environment in which anaerobic organisms exist, and can reduce sulfates to hydrogen sulfide and sulfuric acid or possibly some other reducing reaction. The acid could then dissolve some of the cement paste.

Other sites will be investigated to verify the effects of zebra mussels on concrete components. Samples for this investigation should be taken with the zebra mussels still attached. Cleaning of the surfaces prior to sampling will remove the spatial relationship of zebra mussel attachment to deterioration.

Recommendations

Examination of concrete surfaces should be made where the infestation is only moderate, so that the surfaces will be easily visible. Mussels must be removed for inspection if the infestation is extensive. The inspectors must determine the areas that require cleaning. Such areas may be designated because of structural importance or their significance to operations, or on the basis of previously observed problems.

References

Headquarters, U.S. Army Corps of Engineers. 1988. "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures," Engineer Regulation 1110-2-100, Washington, DC.

Keeney, C. A. 1987. "Procedures and Devices for Underwater Cleaning of Civil Works Structures," Technical Report REMR-CS-8, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Stowe, R. L., and Thornton, H. T., Jr. 1984. "Engineering Condition Survey of Concrete in Service," Technical Report REMR-CS-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.