



**SIMCO**

# ST. LAWRENCE SEAWAY LOCKS

## **RISK ANALYSIS & REPAIR SCENARIOS FOR THE REHABILITATION OF ST. LAMBERT, BEAUHARNOIS & ST. CATHERINE LOCKS AFFECTED BY ALKALI AGGREGATE REACTION (AAR)**

Established in 1998, the Saint Lawrence Seaway Management Corporation (SLSMC) is responsible for the safe and efficient movement of marine traffic through its Canadian Seaway facilities. The Seaway is a deep draft waterway extending 3,700 km (2,340 miles) from the Atlantic Ocean to the head of the Great Lakes and includes 13 Canadian and 2 U.S. locks.

Built over 50 years ago, the Saint-Lambert, Côte Sainte-Catherine and Beauharnois superior and inferior locks now suffer from AAR (Alkali Aggregate Reaction). Over the past several years, the SLSMC has undertaken a series of measures to monitor and analyze the degradation problem and possible impacts on its structures. A yearly maintenance program

was developed and the work performed over the last 30 years totaled about \$7 million. Faced with such costs, it was imperative to fully understand the degradation problem and its progression over time in order to effectively plan and manage interventions and required expenses in the short, medium to long term.

The consequences to this degradation problem are progressive loss of lateral clearance of the locks and progressive misalignment of heavy mechanical elements. Therefore, without any major interventions, the passage of the largest ships allowed in the SLS will become critical under winter (icy) conditions.

# ST. LAWRENCE SEAWAY LOCKS - RISK ANALYSIS & REHABILITATION PLAN

SLSMC's objectives were to determine the best possible strategies (technical solution, intervention, maintenance program, operating strategy, etc.) to manage the risks associated to the AAR problem and various degradation issues that could impact the proper functioning of the locks and to extend their service life by 50 years.

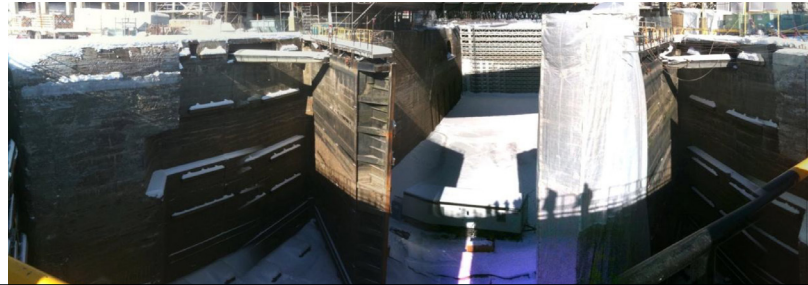
AAR is only one of the many factors that might be fully or partly responsible for the deterioration and premature loss in serviceability of the monoliths. AAR and other degradation mechanisms can result in expansion and cracking of concrete elements, leading to a reduction in the service life of the locks affected. Therefore it was necessary to find the most appropriate solutions in order to better control the impacts on the effective operation of the SLS locks.

In order to ensure the best possible solutions were provided for the effective and efficient rehabilitation of the locks, a panel of experts was formed. The panel consisted of specialized experts from Oxand, SIMCO and Hatch engineering firms.

The panel's scope of work consisted in a list of potential solutions while using a risk-based filtering approach to ensure: the effectiveness of potential solutions in reducing the levels of risks; the identification of risks inherent to the solutions identified; and the constraints associated with implementing the recommended solutions while maintaining normal SLS operations.

**SIMCO's scope of work in this project was to:**

- Conduct a complete review and critical analysis of existing studies (over 50 studies were reviewed and analyzed) on AAR degradation mechanism and its potential effects over time
- Provide an expert opinion as to the rehabilitation of the structures in considering AAR degradation
- Perform concrete material characterization and numerical simulations with STADIUM® to determine the current extent of AAR deterioration affecting the structures and its likely progression over time as well as identify other potential degradation mechanisms
- Help formalize the process as to the risks and costs to be taken into consideration in the prioritization of identified repair solutions
- SIMCO provided SLSMC with an accurate deterioration assessment and recommended potential solutions to remove the deteriorated material considering time and budget constraints.



## **CLIENT OBJECTIVES**

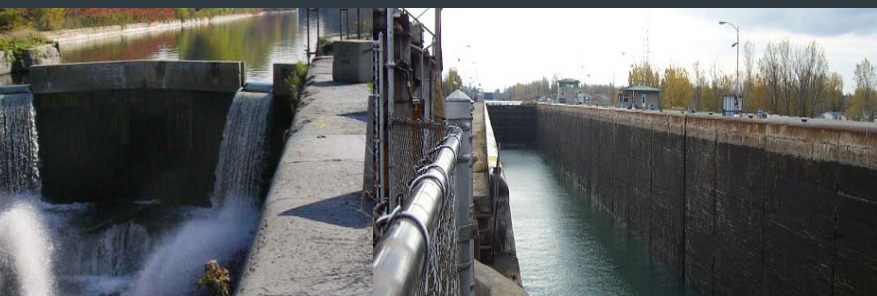
- Identify practical solutions for reducing the impacts of AAR on the normal operation of the SLS locks
- Determine repair mock-up tests that could be executed during the winter months (January to mid-March) so that navigation of vessels would not be impacted
- Determine the optimal approach once the mock-up tests have been validated
- Select the most effective and efficient rehabilitation strategy to extend the service life of the locks by 50 years

## **SIMCO'S SOLUTION**

- Conduct a comprehensive review and analysis of related documents concerning AAR degradation mechanism and possible mitigation strategies
- Elaborate repair scenarios and mock-up tests to be implemented on monoliths during the winter navigation break
- Define tests to be performed that would provide additional information in order to optimize the final rehabilitation approach
- Identify complementary studies required to assist in making the final selection of rehabilitation strategies

## **RESULTS**

- A better understanding of the impacts that AAR will have on the structural integrity of the locks
- The definition of mock-up tests to be performed that would allow SLSMC to determine the most cost-effective solution to repair and rehabilitate the monoliths affected
- Effective mitigation strategies and solutions that would not affect normal operations of the locks



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