Debris Mitigation Methods for Bridge Piers

tech transfer summary

The results of this study provide a thorough presentation of the methods currently or previously used to prevent debris-inflicted damage.

Problem Statement

Debris accumulation on bridge piers is an on-going national problem that can obstruct waterway openings at bridges and also result in significant erosion of stream banks and scour at abutments and piers.

In some cases, debris accumulation can adversely affect the waterway opening operation or cause failure of the structure. In addition, removal of debris accumulation is difficult, time consuming, and expensive.

Background

Only limited research has been conducted to determine the best method(s) for debris mitigation. Several methods have been employed; yet objective comparisons of multiple methods have rarely been completed.

Objective, Methodology, and Scope

The objective to this phase of the study is to determine the current state-of-the-practice for debris mitigation by performing a literature review and national survey of state departments of transportation (DOTs) and to make comparisons of performance and cost effectiveness of employed methods.

Debris accumulation at a bridge pier on the Skunk River in Ames, Iowa

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RESEARCH PROJECT TITLE
Debris Mitigation Methods for Bridge Piers

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The Bridge Engineering Center (BEC) is part of the Institute for Transportation (InTrans) at Iowa State University. The mission of the BEC is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

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The literature review included a search of publications, products, and pier design recommendations that provide methods to mitigate debris accumulation at bridges. The report includes a section that details the results.

The nationwide survey resulted in 32 responses from 31 different states. The entire US was fairly well represented, given that at least one response was received from every region. The report includes the survey questions, answers, and observations. The observations are also included here under Key Findings.

Key Findings

Given the survey responses received, only a fraction of the states have attempted some method of debris mitigation. The apparent need for mitigation is clear for some states, yet others may have minimal or no need at all.

Of all the methods listed, debris deflectors were most commonly implemented and with varying success. The states that have used this method rated the performance as satisfactory, aside from California and Missouri, which rated the performance as good and poor, respectively. The cost effectiveness of debris deflectors was never rated higher than satisfactory by any state.

Alaska has attempted more of the mitigation methods than any other state; debris racks, crib structures, in-channel debris basins, and river training structures have been used. In each case, the performance and cost effectiveness was rated as satisfactory, excluding in-channel debris basins where the cost effectiveness was rated as good.

The performance of any one debris method was never rated higher than good. Those receiving a performance rating of good were debris deflectors and debris sweepers in California.

Likewise, the cost effectiveness of any one debris mitigation method was never rated higher than good. Those receiving a rating of good were in-channel debris basins in Alaska, debris fins in Kansas, and river training structures in Wyoming.

Four states implemented mitigation techniques that were rated as poor for both performance and cost effectiveness. Illinois, Minnesota, Missouri, and Utah rated debris sweepers, debris sweepers, debris deflectors, and debris racks as poor, respectively.

Only one state rated the performance of one method as good and the cost effectiveness of that same method as poor. California rated debris sweepers in this way.

National survey results showing overall performance and cost-effectiveness ratings for debris deflection methods

Method	Poor		Satisfactory		Good		Excellent	
Debris Fins	0	0	2	1	0	1	0	0
Debris Deflectors	2	2	8	7	1	0	0	0
Debris Sweepers	2	3	0	0	1	0	0	0
Debris Racks	1	1	3	3	0	0	0	0
Booms	0	0	0	0	0	0	0	0
Crib Structures	0	0	2	2	0	0	0	0
In-channel Debris Basins	0	0	1	0	0	1	0	0
River Training Structures	0	0	4	3	0	1	0	0
Other	0	0	1	1	1	1	0	0

Performance Rating Cost-Effectiveness Rating

Five locations indicated that other methods of debris mitigation were implemented. These methods included rounded pier nose at upstream side (District of Columbia), singular circular piers (South Carolina and Vermont), and solid wall type piers (South Dakota and Vermont). Texas did not indicate what other method of debris mitigation was used.

Implementation Readiness

Numerous debris mitigation methods have been used nationwide with varying degrees of success; even so, no apparent “best” option exists. Site-specific conditions often determine the performance of any one system.

For this reason, it would be wise for design engineers to first study the debris source, transport characteristics, and accumulation tendencies at individual bridge locations. Other factors including maintenance costs, aesthetics, and environmental impacts must also be considered.

With this knowledge and consideration, along with the previous accounts of successes and failures, a mitigation option can be selected that best addresses the situation and need.

Implementation Benefits

The apparent effects of debris accumulation on bridge structures have made it clear that a need for debris mitigation exists. Without mitigation, bridge structures are susceptible to scour, overloading, or even collapse.