Ohio Department of Transportation Research Project Fact Sheet

Benefit Analysis of Barrier Inlet Screens

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Report Date	May 2024
Project Number	PID 114243

The Problem

A wide range of debris from fine sediments to hubcaps and tires can enter ODOT roadside drainage inlets, disrupting the hydraulic capacity of sewer systems. This often leads to increased stormwater spread and ponding on roadways – a danger to motorists. Barrier inlets are particularly vulnerable to these issues given their minimal separation from the travel lane and their long, narrow inlet geometry. The use of barrier inlet screens can alleviate these issues by reducing the amount of debris entering inlets. This research project provided ODOT with the knowledge and evaluation criteria to determine which inlet screen products and/or practices are best suited to protect barrier inlets located along roadways.

Figure 1: Field monitoring site in Columbus, Ohio

Research Approach

The research team comprised of ms consultants inc., Ohio State University (OSU), and University of Iowa IIHR—Hydroscience & Engineering performed a detailed literature review to develop a comprehensive list of products and practices aimed at preventing debris from entering barrier inlets. The effectiveness of these products and practices was determined using field monitoring and laboratory testing. Five proprietary screens and three non-proprietary screens (which were developed and fabricated by the project team) were tested as part of this research.

Field monitoring was performed by OSU at sites located on urban interstate highways near Cleveland, Columbus, and Cincinnati (Figure 1). Remote sensing technology was installed to monitor a variety of performance metrics, including debris accumulation, water ponding depth, and spread. The research team also evaluated products based on ease of installation, maintenance, and long-term durability. Field testing of maintenance techniques was also performed to ensure long-term hydraulic function of the screens and inlets.

IIHR performed full scale physical modeling by constructing a 12-foot wide, 50-foot-long test channel to evaluate the hydraulic performance of inlet screen products (Figure 2). The test channel featured adjustable longitudinal and cross slopes such that each product could be tested under a variety of simulated roadway conditions. Additionally, a variety of inlet configurations was tested, such as those on-grade and in sag conditions, as well as inlets with and without accompanying catch basin grates. Simulated debris/trash was also incorporated into the test channel to evaluate the debris removal efficiency of screening devices and the subsequent impacts on hydraulic capacity at the inlet.

ms consultants performed hydraulic analysis and cost-benefit analysis to optimize the screen design for hydraulic efficiency, debris removal capability, installation/maintenance requirements, and cost savings to ODOT. The potential design implications were also evaluated to inform potential modifications to ODOT's drainage guidance.

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This research was sponsored by the Ohio Department of Transportation and the Federal Highway Administration.

Findings

Barrier inlet screens provided considerable debris removal at field monitored barrier inlets. During the 13 events where OSU collected debris captured by inlet screens, a total of 271 lbs. of material was captured. It was also determined that proprietary screens required more frequent maintenance and clogged faster compared to non-proprietary inlet screens designed and fabricated by the research team. All screens were installed for the winter seasons of 2022-2023 and 2023-2024 and were not impacted negatively by snow and ice removal operations. The use of an air compressor, pressure washer, or hand tools paired with a regenerative air street sweeper effectively removed debris and restored the hydraulic capacity of clogged screens.

Figure 2: Full-scale physical model of barrier inlet with screen partially occluded in IIHR's hydraulics laboratory.

Laboratory testing showed that barrier inlet configuration (i.e., sag inlet vs. on-grade inlets, with or without an accompanying catch basin), longitudinal slope, and simulated flow rate significantly impacted hydraulic capture efficiency. In laboratory testing, screens installed on a barrier inlet with a catch basin grate were shown to cause negligible changes in runoff spread and depth. Additionally, screens installed on a barrier inlet with a catch basin grate exhibited greater hydraulic capacity than CDSS calculated inlet capacities for unmodified (no screen) barrier inlets with catch basin grates. Overall, findings from laboratory and field testing indicated that fabricated inlet screens were most efficient at reducing large debris while maintaining high hydraulic efficiency. Fabricated inlet screens were also the most cost effective due to less frequent maintenance, ease of installation, and lower fabrication costs.

Recommendations

The research team recommended that barrier inlet screens be implemented along ODOT roadways where trash and debris are known issues. Upon further field observations and better understanding of long-term maintenance needs, ODOT should consider expanding the use of barrier inlet screens to more locations with a history of basin clogging, based on discussions with maintenance staff. Ultimately, if it continues to be found to be a beneficial practice, ODOT should consider barrier inlet screens during scoping of new construction projects.

The expected benefits from barrier inlet implementation include cost savings from reduced inlet and sewer cleaning, safer working conditions for ODOT maintenance personnel, and reduced debris entering receiving waterways.

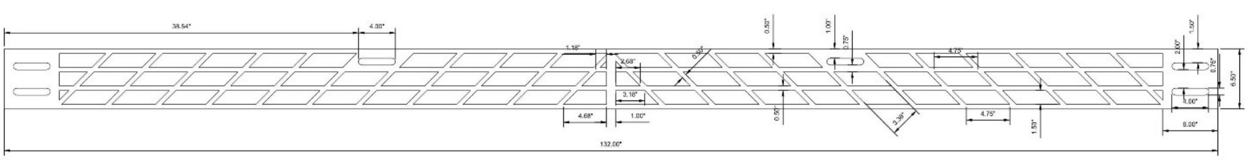

Figure 3: Recommended fabricated screen design.

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