February, 2014

DEVELOPMENT OF SELF-CLEANING BOX CULVERT DESIGN

(IHRB RESEARCH PROJECT TR-619)

Sponsor
IOWA HIGHWAY RESEARCH BOARD

Principal Investigator,
Dr. Marian Muste
Research Engineer and Adjunct Professor
IIHR-Hydroscience & Engineering
Civil and Environmental Engineering
The University of Iowa
Iowa City, Iowa 52242
C. Maxwell Stanley Hydraulics Lab
marian-muste@uiowa.edu
319-384-0624
http://www.iihr.uiowa.edu

About
IIHR-HYDROSCIENCE & ENGINEERING

IIHR's historic C. Maxwell Stanley Hydraulics Laboratory was dedicated as a National Historic Civil Engineering Landmark in 2005, placing it among the major structures of national importance to the engineering profession. The mission of the IIHR is to conduct research in water resources and environmental engineering. The sponsors of this research are not responsible for the accuracy of the information presented herein. The conclusions expressed in this publication are not necessarily those of the sponsors.

Self-cleaning culvert designs can prevent formation of sediment deposits at multi-box culverts using the hydraulic power of the stream.

BACKGROUND

The present study is an integral part of a multi-phase study focused on the design and implementation of self-cleaning culverts, i.e., configurations that prevent the formation of sediment deposits after culvert construction or cleaning. Box culverts are generally designed to handle events with a 50-year return period, and therefore convey considerably lower flows much of the time. While there are no issues with conveying high flows, many multi-box culverts in Iowa pose a significant problem related to sedimentation due to the highly erosive Iowa soils. Phase I of this IHRB project (TR-545) led to an innovative solution for preventing sedimentation. The solution was comprehensively investigated through laboratory experiments and numerical modeling aimed at screening design alternatives and testing their hydraulic and sediment conveyance performance. Following this study phase, IHRB suggested implementation of the optimal mitigation design found in Phase I to a field site.

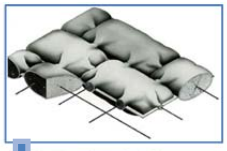
OBJECTIVES

The main objectives of this research are:

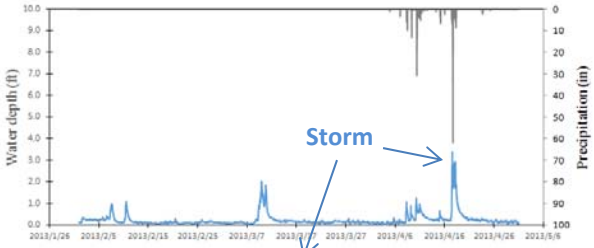
a. Identification of a multi-box culvert prone to sedimentation continuous for long-term monitoring.
b. Monitoring of the selected culvert prior and after to sediment cleanup for assessing the efficacy of the self-cleaning designs and the role of other factors involved in triggering sedimentation.
c. Establishing self-cleaning culvert design specifications.
d. Monitor the self-cleaning culvert after construction. For this purpose a real-time web-camera and a stage sensor were deployed at the culvert site.

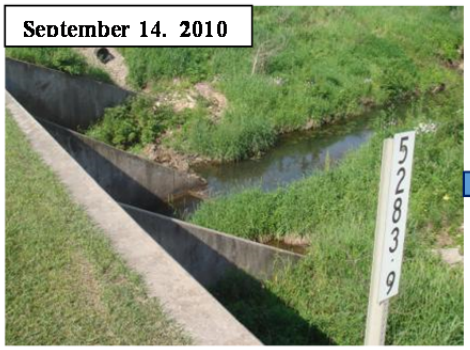
METHODS

The site selected for implementation of the new design is a three-box culvert crossing Willow Creek on IA Hwy 1W in Iowa City. The second part of Phase II of the study was aimed at monitoring the constructed self-cleaning structure. The superficial layer of the finished culvert geometry was attained with geomat, a newer and flexible bed protective solution. The specific geomat used for the construction of the self-cleaning structure at our site is articulating block mats (ABM) produced by Texicon (http://www.texicon.com).



A monitoring program was designed and implemented for the culvert starting in September 2010 and ending in December 2013. The goal of this monitoring phase was to document individual and cumulative effects of storms propagating through the culvert with special attention given to sedimentation. For this purpose, a thorough set of quantitative and qualitative observations have been made and subsequently corroborated with stage and precipitation measurements after each storm.



IMPLEMENTATION

The evidence garnered in this phase of the study demonstrates the good performance of the self-cleaning structure in mitigating the sediment deposition at culverts. The design concept can be implemented at the culvert construction time or can be applied by retrofitting culverts that displayed sedimentation concerns.