Water Resources Infrastructure Research and Development

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Engineer Research and Development Center

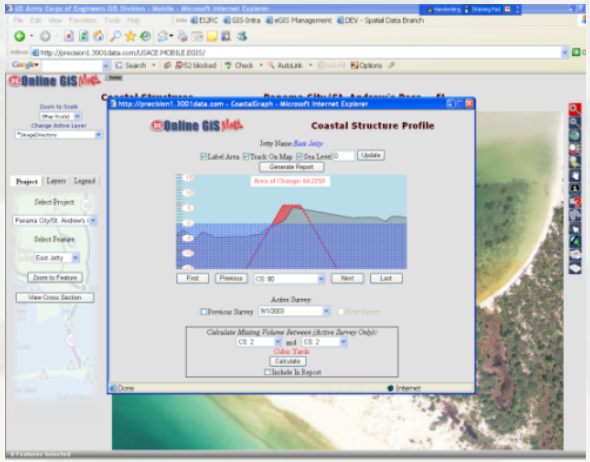
Coastal and Hydraulics Laboratory

US Army Corps of Engineers
BUILDING STRONG®

Research and Development Objectives

Enable sustainable water resources infrastructure through development and application of state-of-the-art technology and innovative management approaches.

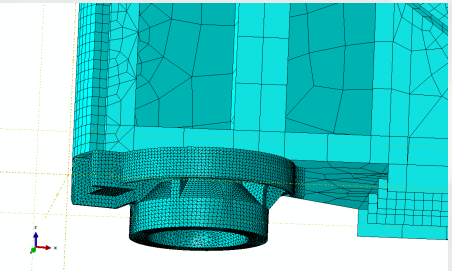
Meet marine transportation, hydropower and infrastructure challenges through research that incorporates engineering, economic, and environmental solutions.



Redesign of Miter Gate Pintle Sockets and Connections

- Development of new pintle socket and connections design that will withstand deterioration of the initial design conditions. Improved Finite Element Model and study method that can be used on other site specific projects.

- **Benefits**
  - This research will reduce the time and costs associated with damaged pintles by providing a design with a much longer service life. It will also reduce the time and cost associated with unscheduled outages now caused by damaged pintles.



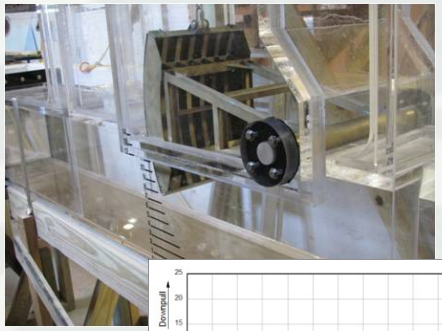
Repair and Replacement Guidance for Lock Culvert Valves

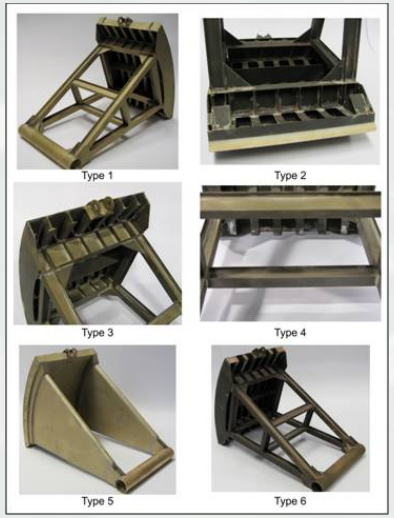
1:15-scale physical model and numerical model

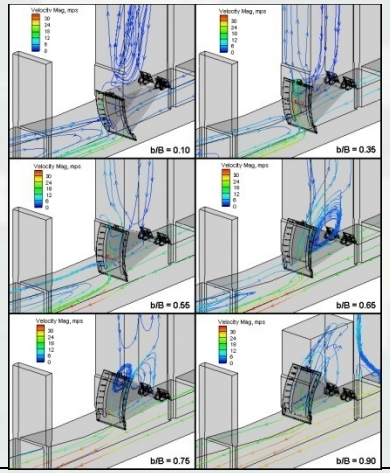
Obtained force and pressure data for 7 different valve designs

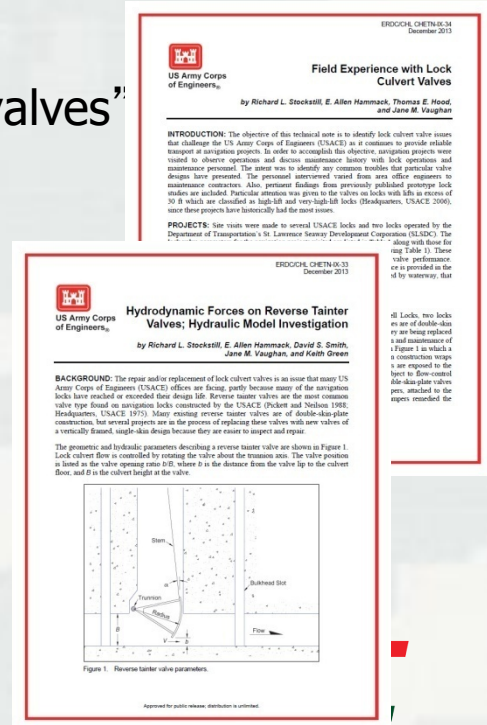
Measure forces and vibration tendencies of vertically-framed reverse tainter valves

- Tech Note: "Hydrodynamic forces on reverse tainter valves; hydraulic model investigation"
- Tech Note: "Field experience with lock culvert valves"








ERDC/CHL CHETN-IX-34
December 2013

US Army Corps of Engineers

Field Experience with Lock Culvert Valves

by Richard L. Stockstill, E. Allen Hammack, Thomas E. Hood, and Jane M. Vaughan

INTRODUCTION: The objective of this technical note is to identify lock culvert valve issues that challenge the US Army Corps of Engineers (USACE) as it continues to provide reliable transport at navigation projects. In order to accomplish this objective, navigation projects were visited to observe operations and discuss maintenance history with lock operations and maintenance personnel. The intent was to identify any common troubles that particular valve designs have presented. The personnel interviewed varied from area office engineers to maintenance contractors. Also, pertinent findings from previously published prototype lock studies are included. Particular attention was given to the valves on locks with lifts in excess of 30 ft which are classified as high-lift and very-high-lift locks (Headquarters, USACE 2006), since these projects have historically had the most issues.

PROJECTS: Site visits were made to several USACE locks and two locks operated by the Department of Transportation's St. Lawrence Seaway Development Corporation (SLSDC). The

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Hydrodynamic Forces on Reverse Tainter Valves; Hydraulic Model Investigation

by Richard L. Stockstill, E. Allen Hammack, David S. Smith, Jane M. Vaughan, and Keith Green

BACKGROUND: The repair and/or replacement of lock culvert valves is an issue that many US Army Corps of Engineers (USACE) offices are facing, partly because many of the navigation locks have reached or exceeded their design life. Reverse tainter valves are the most common valve type found on navigation locks constructed by the USACE (Pickett and Neilson 1988; Headquarters, USACE 1975). Many existing reverse tainter valves are of double-skin-plate construction, but several projects are in the process of replacing these valves with new valves of a vertically framed, single-skin design because they are easier to inspect and repair.

The geometric and hydraulic parameters describing a reverse tainter valve are shown in Figure 1. Lock culvert flow is controlled by rotating the valve about the trunnion axis. The valve position is listed as the valve opening ratio b/B, where b is the distance from the valve lip to the culvert floor, and B is the culvert height at the valve.

Figure 1. Reverse tainter valve parameters.

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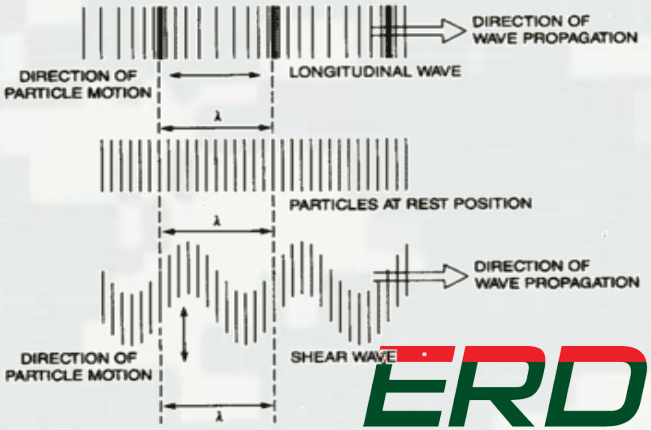
Composite Straps for HSS Crack Control

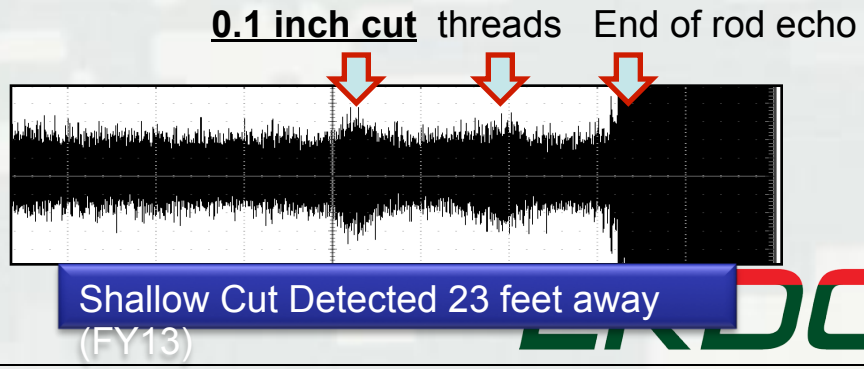
Trunnion Anchor Rod Tension Measurement

- Problem: Failing trunnion anchor rods. Which rods still have correct tension.
- Approach: Use the travel time of acoustic signals to calculate the tension in the rod.
- Status: Working on a more powerful sensor in attempt to obtain data for rods longer than 45’; grouted rods were tested at Kaskaskia Lock and Dam; Technical Note in review
- POC: Mike McInerney – michael.k.mcinerney@usace.army.mil - 217-373-6759



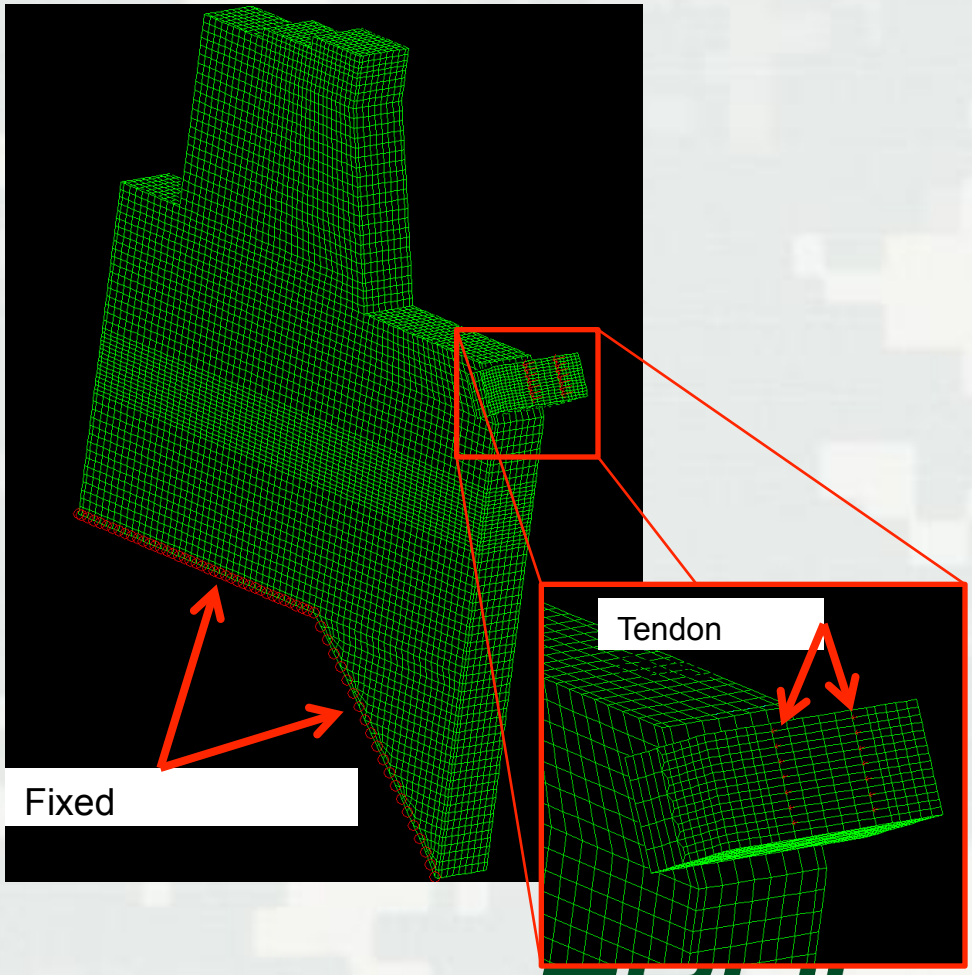
Trunnion Anchor Rod Microcrack Detection

- Problem: Failing trunnion anchor rods. Microcracks form in the rods prior to failure
- Approach: Use NDT to assess the health of the rod by (1) detecting the presence of microcracks (confident) & (2) determining size the cracks (targeted capability)
- Status: Using guided wave acoustic signals; determined frequencies for best performance; seeing 'flaws' created in the lab in rods > 55'; prototype tested in field on rods > 85'
- POC: Jim Evans – james.a.evans@usace.army.mil - 601-634-2535



Trunnion Anchor Rod Repair & Replacement

- Problem: Failing trunnion anchor rods. Need to replace corrosion inhibitor; method to replace damaged / broken rods
- Approach: Utilize test bed at ERDC to develop procedures for inhibitor removal / re-installation; Design retrofit to replace damaged rods & test vendor removal techniques
- Status: FEM analysis of effects of damaged rods and repair options; trying to get contract w/ for replacement of rods and corrosion protections
- POC: Joe Padula – joseph.a.padula@usace.army.mil - 601-634-4451



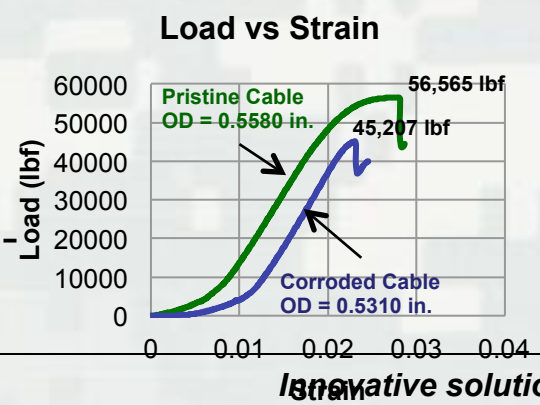
Multi-strand Anchor Tendons

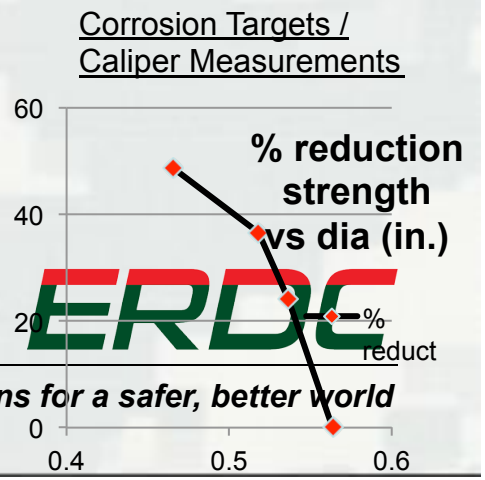
- Problem: Deteriorating multi-strand ground anchors; uncertainty with remaining strength
- Approach: Probabilistic assessment of the reduced capacity by (1) deteriorating cables in the lab, (2) determining x-sect lost; (3) load cable to breaking; (4) correlate to remaining x-sect of cable on-site; (5) provide software tool to perform probablilitc analysis
- Status: Lab deterioration and testing progressing well; software development is on track - due FY15.
- POC: Bob Ebeling – robert.m.ebeling@usace.army.mil – 601-634-3458

Anchor Heads

New Corroded

Corroded seven-strand wires

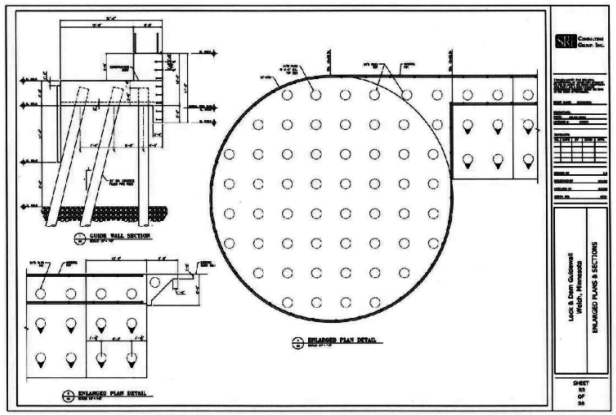




Flexible Approach Walls

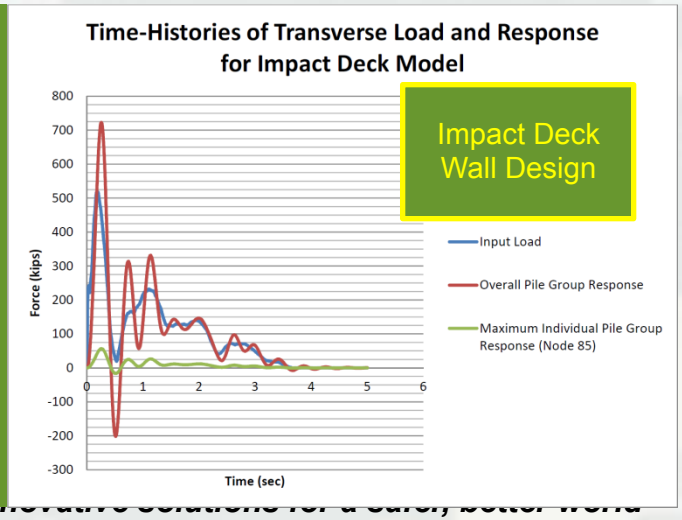
- Problem: Lock approach walls are typically constructed to be ‘rigid’; flexible systems can reduce construction cost and improve safety at the site
- Approach: Develop engineering methodologies and PC-software for the design/analysis of energy absorbing, flexible approach walls founded on ‘clusters’ of vertical and batter pile groups
- Status: PC software pkgs developed for deck response and pile group analysis, with manuals.
- POC: Bob Ebeling – robert.m.ebeling@usace.army.mil - 601-634-3458

The Impact Deck



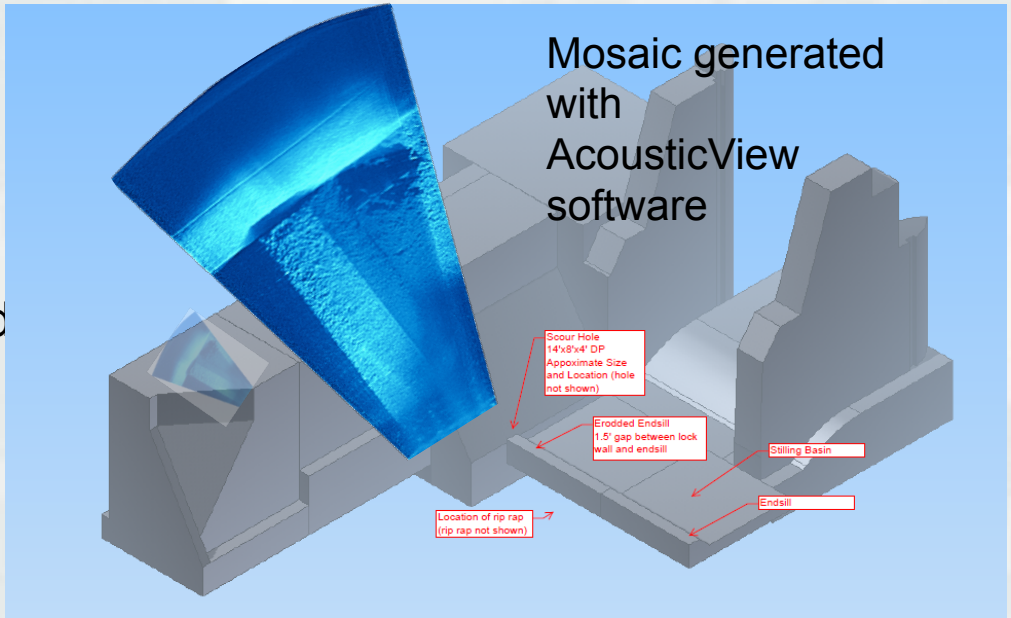
Dynamic: Inertia Effects of the impacted structure cause the sum of all the pile group responses to vary from the input load.

Load Sharing: The peak pile group response is much lower than the input load or the overall response because pile groups share the load.



Acoustic Camera

- Problem: Turbid water causes significant challenge for determining details about underwater features
- Approach: Utilize an high-resolution, ultrasonic-acoustic camera to inspect features in turbid waters
- Status: Able to deploy and use the sensor. Development effort completed. Additional capabilities could be added.
- POC: Jim Evans – james.a.evans@usace.army.mil - 601-634-2535



Ormond Lock and Dam, Arkansas River

3D Representation of scour hole generated from edge contours.

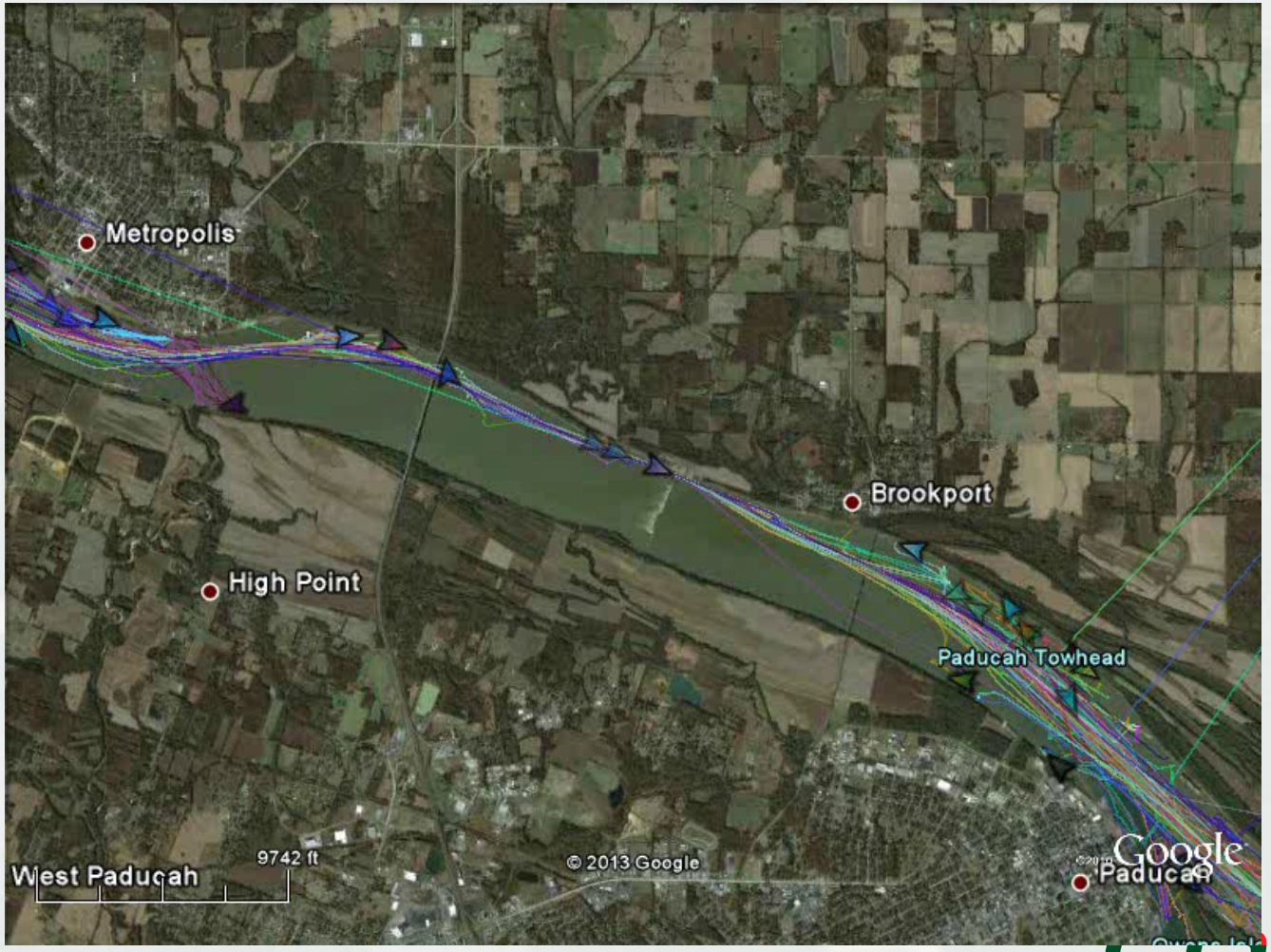
Nanotube Epoxy Paint Field Demo

- Problem: This nanotube epoxy paint, a very good corrosion inhibitor, has been tested in the lab and on a water tower with good success, but has not been tested in a submerged environment
- Approach: Identify a field site where a large HSS can be painted to monitor the performance of this paint; Epoxy cost is higher than traditional paint system, but only requires 2 coats instead of 3 (less material and labor)
- Status: Looking for a field site for demonstration / test
- POC: Susan Drozdz – susan.a.drozdz@usace.army.mil - 217-373-6767

Lock Operations Management Application (LOMA)

- Purpose:
  - Provide end users information needed for decision support
- Goals:
  - Increase lock operator situational awareness
  - Provide vessel operators better information
  - Provide better information to Corps management
  - Exchange information with external users
- AIS is the central LOMA technology

L&D 52


Metropolis
Brookport
High Point
Paducah Towhead
West Paducah
9742 ft
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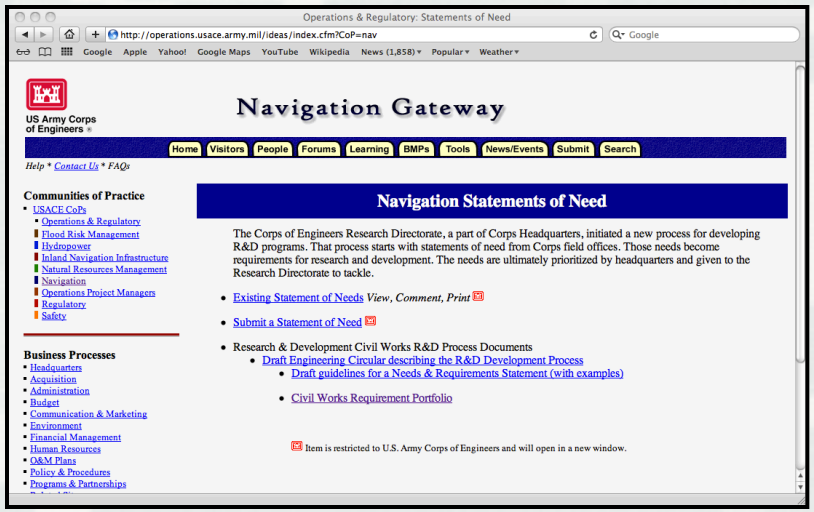
Statements of Need

how it all begins

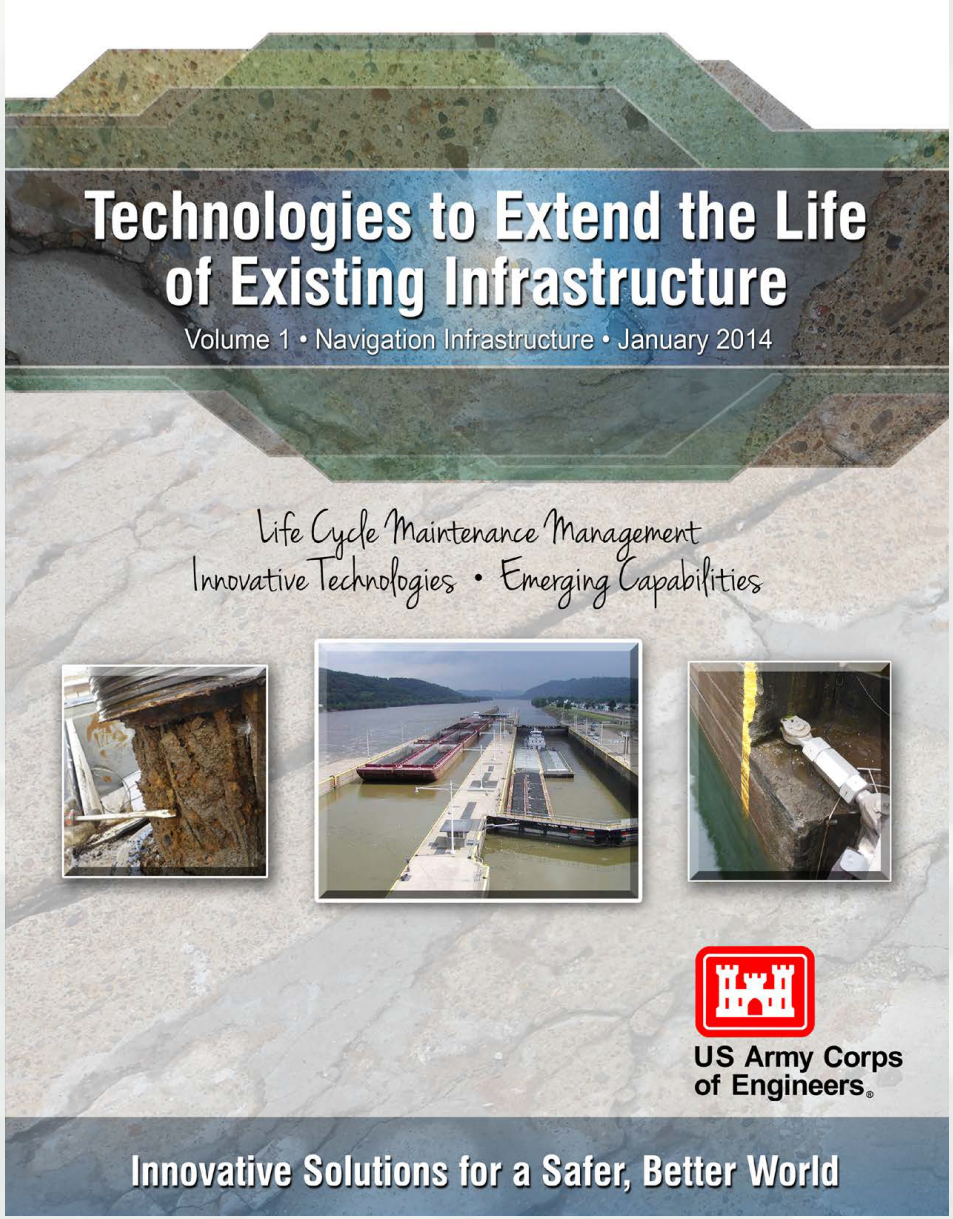
- Title
- Need that Drives Requirement
- Extent of Need Across USACE
- Requirement
- Consequences if Requirement Not Met
- Product Recommendation
- Originator



Navigation Gateway

http://operations.usace.army.mil/navigation.cfm

http://operations.usace.army.mil/pdfs/ExtendingNavInfrastructureLife.pdf



Questions/Discussion