

Lock Gate Condition Automated Decision Support System



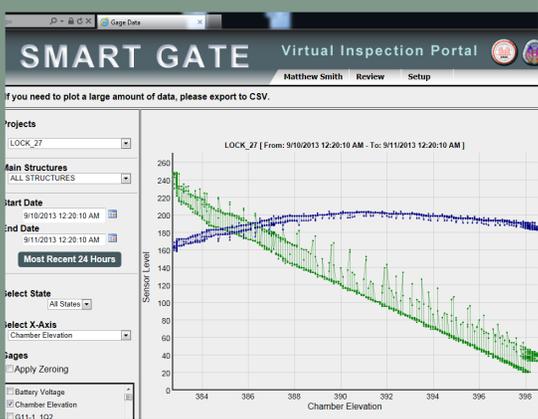
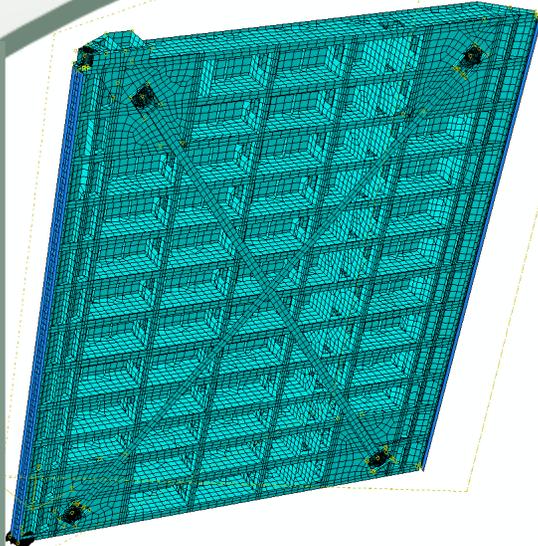
Engineer Research and Development Center

SMART Gate 2.0

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ERDC

11 February 2014



US Army Corps of Engineers®

Outline

- **Project Overview**
- **SMART Gate Versions**
- **Condition Monitoring Targets**
- **Lock Projects and Schedule**
- **Tech Transfer**



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Project Overview

What is the need?

- Navigation RARG Statements of Need:
 - ▶ 2008-N-32
 - ▶ 2008-N-79
 - ▶ 2011-N-14
 - ▶ 2012-N-7
 - ▶ 2012-N-13
 - ▶ 2013-N-38
- Infrastructure HQ-PDT Problem Statement #5
- Worst First - \$79M unscheduled lock gate repairs 1999-2005
- Need for Data-to-Decision Support (D2D) structural health monitoring (SHM) for proactive maintenance/replacement plans
- A high-performance metric for USACE used by OMB is unscheduled lock outages.



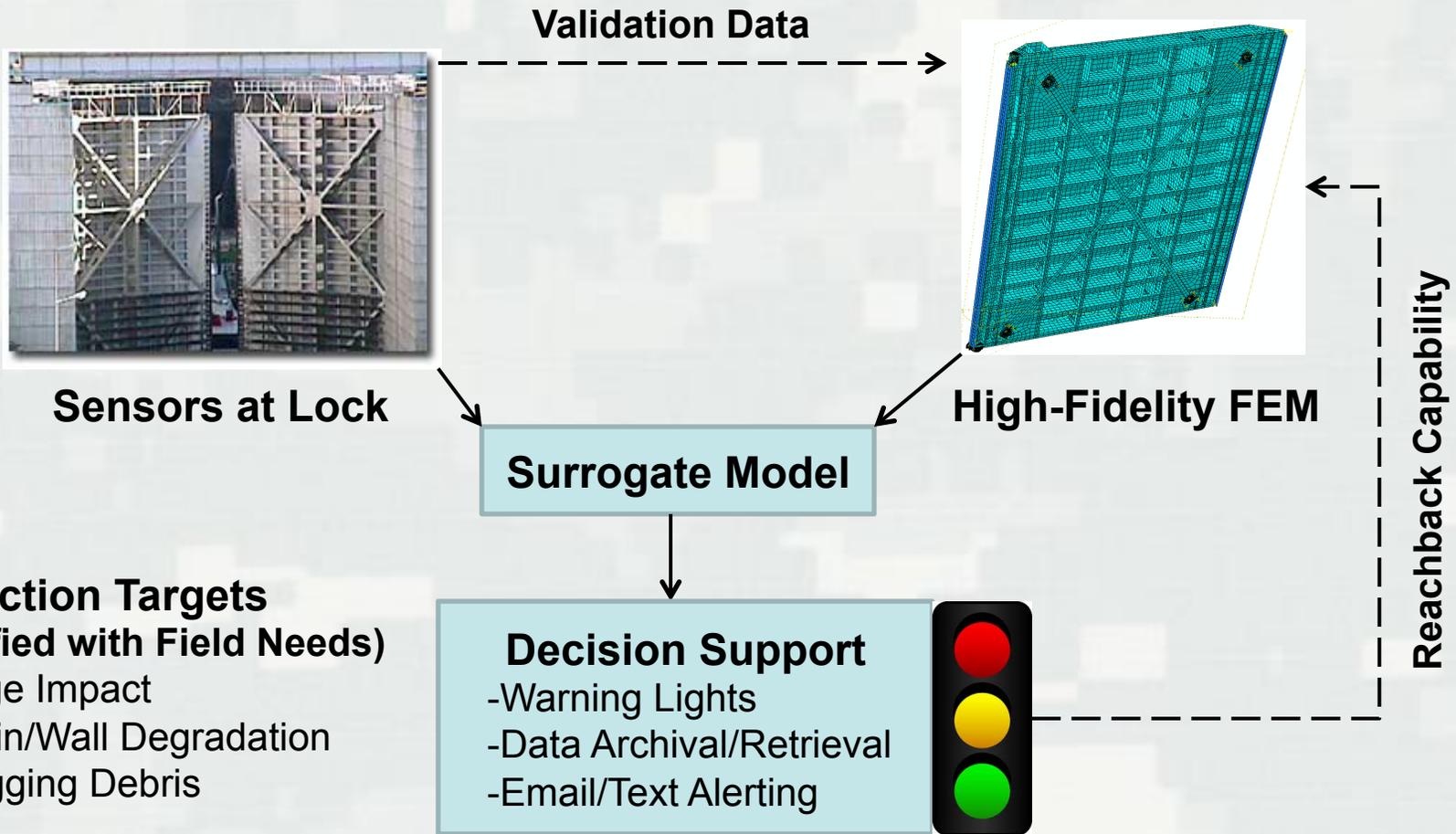
Project Overview

What are we doing?

- Early warning system
 - Automated detection
 - Leading to catastrophic conditions
 - Useful to field
 - Quick to implement (within current capabilities)
 - Traffic light type signals for lock operator
 - LOMA implementation
 - Data-portal for post-warning decision support
 - Affordable
 - Limited to chambers with miter gates (for now)
 - Incorporate structural and mechanical systems
 - Design guidance and specifications for existing and new gates



Project Overview



SMART Gate Versions

Structural Monitoring and Analysis in Real-Time (SMART)

Version 1.0	Version 2.0
Many Sensors	Few Sensors
No Detection Targets	Carefully Selected Targets
\$600k+ per Chamber	Goal of ~\$250k per Chamber
No Automated Decision Support	Automated Event Detection using FEM
Easy Data Access and Plots via Website https://smartgatedev.usace.army.mil	Same Web Access with Plotting + LOMA Warning Traffic Lights
Manual Alarms (email & text)	Auto and Manual Alarms (email & text)
No Elec/Mechanical Sensors	Incorporated Elec/Mech. Sensors



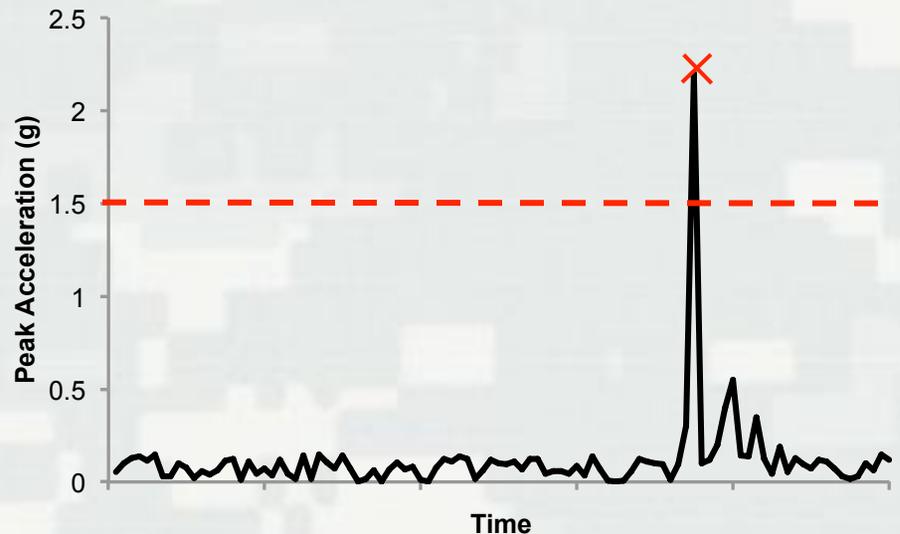
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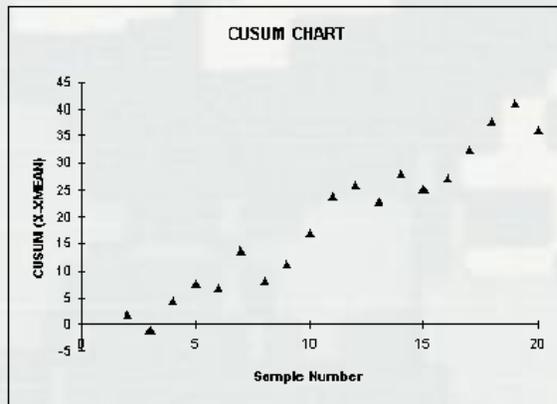
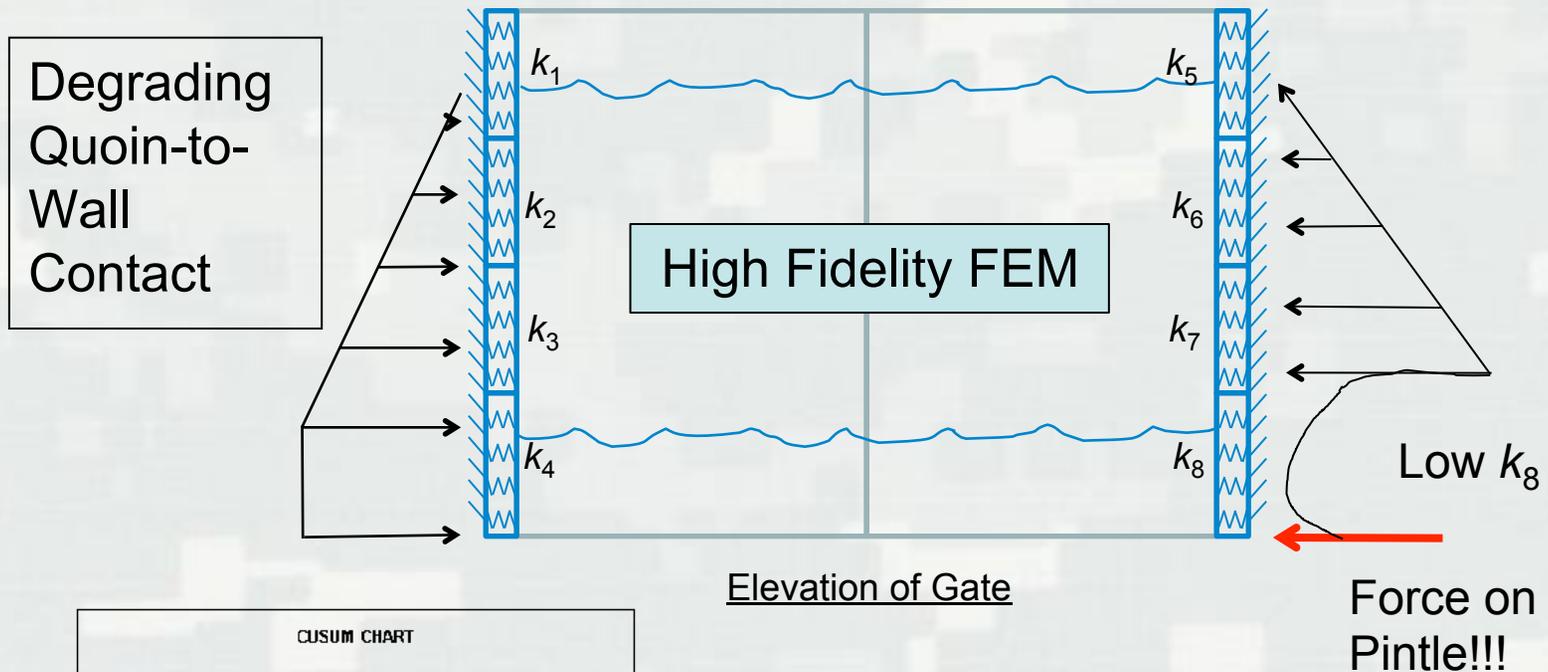
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Condition Monitoring Targets

- Three Initial Targets Developed with Field (District Ops and Eng) PDT
 - Lock Gate Barge Impact
 - Degrading Quoin-to-Wall Contact
 - Dragging/Trapped Debris
- Barge impact
 - Test acceleration vs. learned thresholds
 - Combined with LOMA can determine parties responsible for repairs



Condition Monitoring Targets



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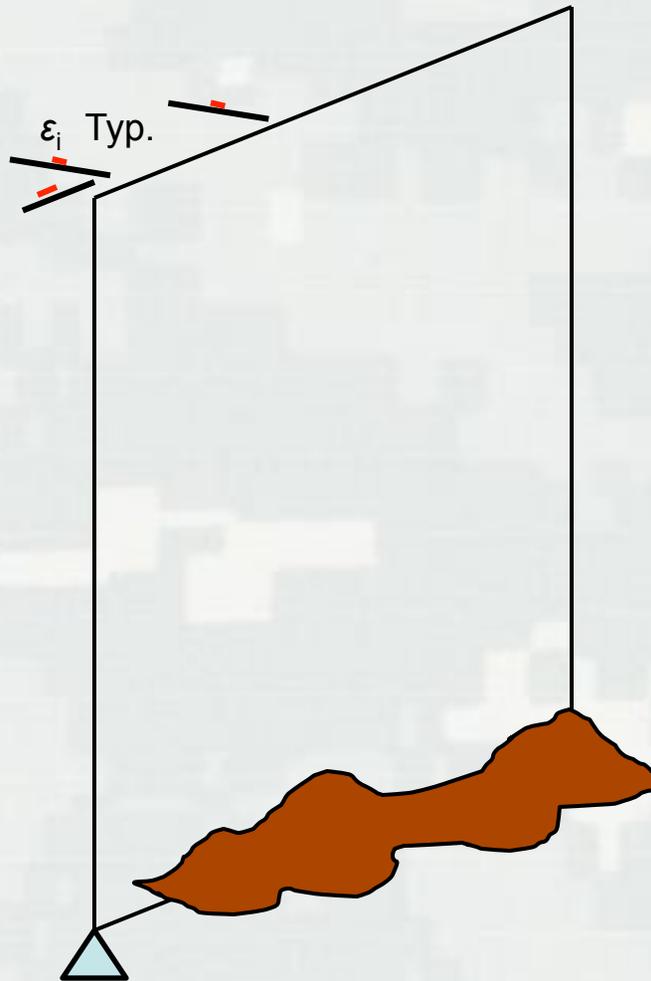


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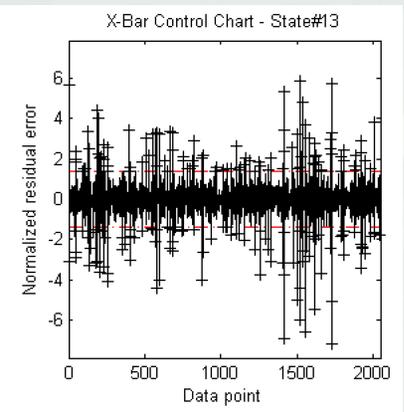
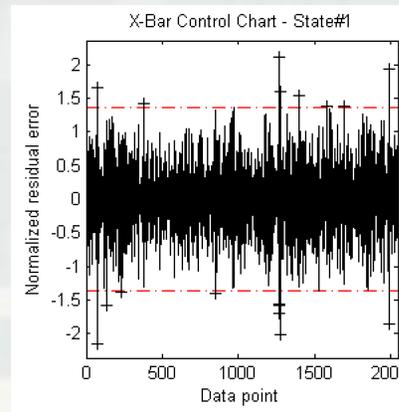
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Condition Monitoring Targets

- Dragging/Trapped Debris



- Forces in anchors and struts indicate dragging
- Auto-regressive time-series techniques
- Statistical process control



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Lock Projects and Schedule

Participating Lock Projects

- Development Site: Lock 27, St. Louis District
- **Demonstration (Pilot) Site: Competitive Selection**

Schedule

- FY14: Algorithm and Hardware Development
- FY14: Implementation/Debugging at Development Site
- **FY15: Demonstration of SMART Gate 2.0**
- FY15 and Beyond: Adding Capabilities through new sensor types, new detection targets, improved reliability, interrelationship between inspection and SHM, integration into asset management, ...



Other Applications

- Fracture Critical Component Monitoring
- Trunnion Friction Monitoring



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Questions...No, Mine for You

- What would you like an automated system to tell you about your lock gates?
- Do you know of a lock that will be dewatered in FY15 that may want to have the pilot system installed?



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Structural Monitoring of Lock Structures to Prevent Failure

Steven Sweeney

Structural Engineer

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11 Feb 2014



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Project Overview

What are we doing?

- Building off of the framework developed in Lock Gate Condition Automated Decision Support System project
- Research advanced monitoring and detection methodologies
 - New sensor or applications for critical components
 - Quoin blocks
 - Pintles
 - Crack detection methods
 - Equipment monitoring
- Integrated analysis of data with modeling
- Long term degradation evaluation



Key Milestones

- FY15 – Field testing of monitoring technologies and analysis methods in conjunction with implementation of SMART Gate 2.0
- FY15 – Identification of site for final demonstration
- FY17/18 – Installation of a structural monitoring system (SMS) on the selected lock
- FY19 – Guidance documents for design and installation of SMS on locks.
 - EM on analysis and system design
 - Guide Specification for SMS system acquisition

