TRB Webinar: Importance of Bridge Inspection and Management

Presentations

- **Importance of Bridge Inspection and Management**
  Malcolm Kerley, Virginia Department of Transportation
- **Bridge Inspection Practices (Synthesis 375)**
  George Hearn, University of Colorado, Boulder
- **Inspection and Management of Bridges with Fracture-Critical Details (Synthesis 354)**
  Robert Connor, Purdue University
- **Monitoring Scour Critical Bridges (Synthesis 396)**
  Beatrice Hunt, STV, Inc.
- **Guidelines for Implementing Quality Control and Quality Assurance for Bridge Inspection**
  Glenn Washer, University of Missouri, Columbia

Moderators and Participants

- **Receiving Your Technical Questions**
  Reggie Gillum, Transportation Research Board,
  202-334-2382
- **Session Moderator**
  Lisa Berardi Marflak, Transportation Research Board
- **Question and Answer Moderator**
  Waseem Dekelbab, Transportation Research Board
- **Question and Answer Participant**
  Thomas Everett, Federal Highway Administration

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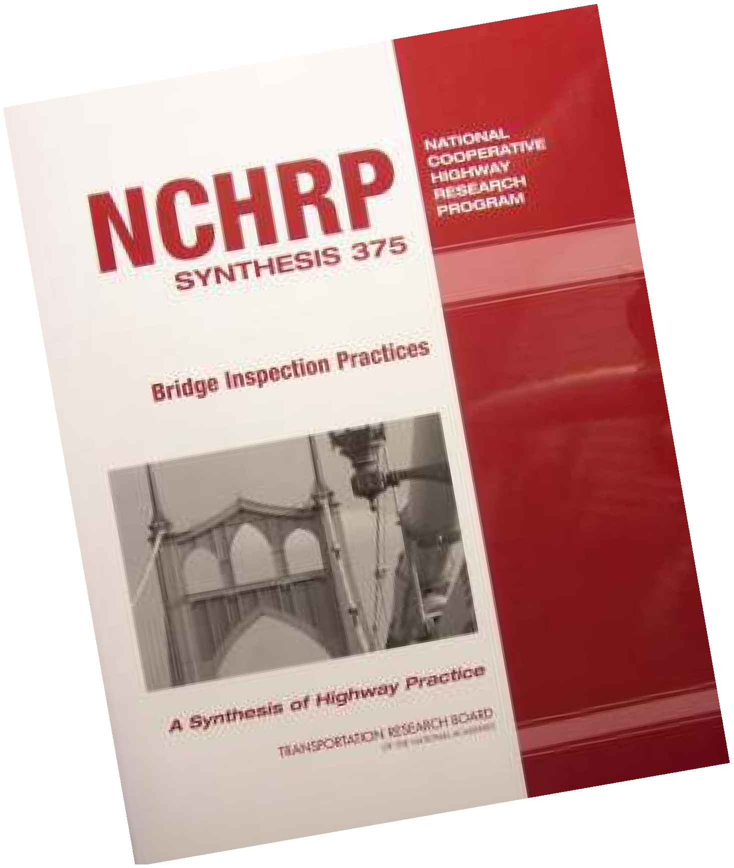
Importance of Bridge Inspection and Management

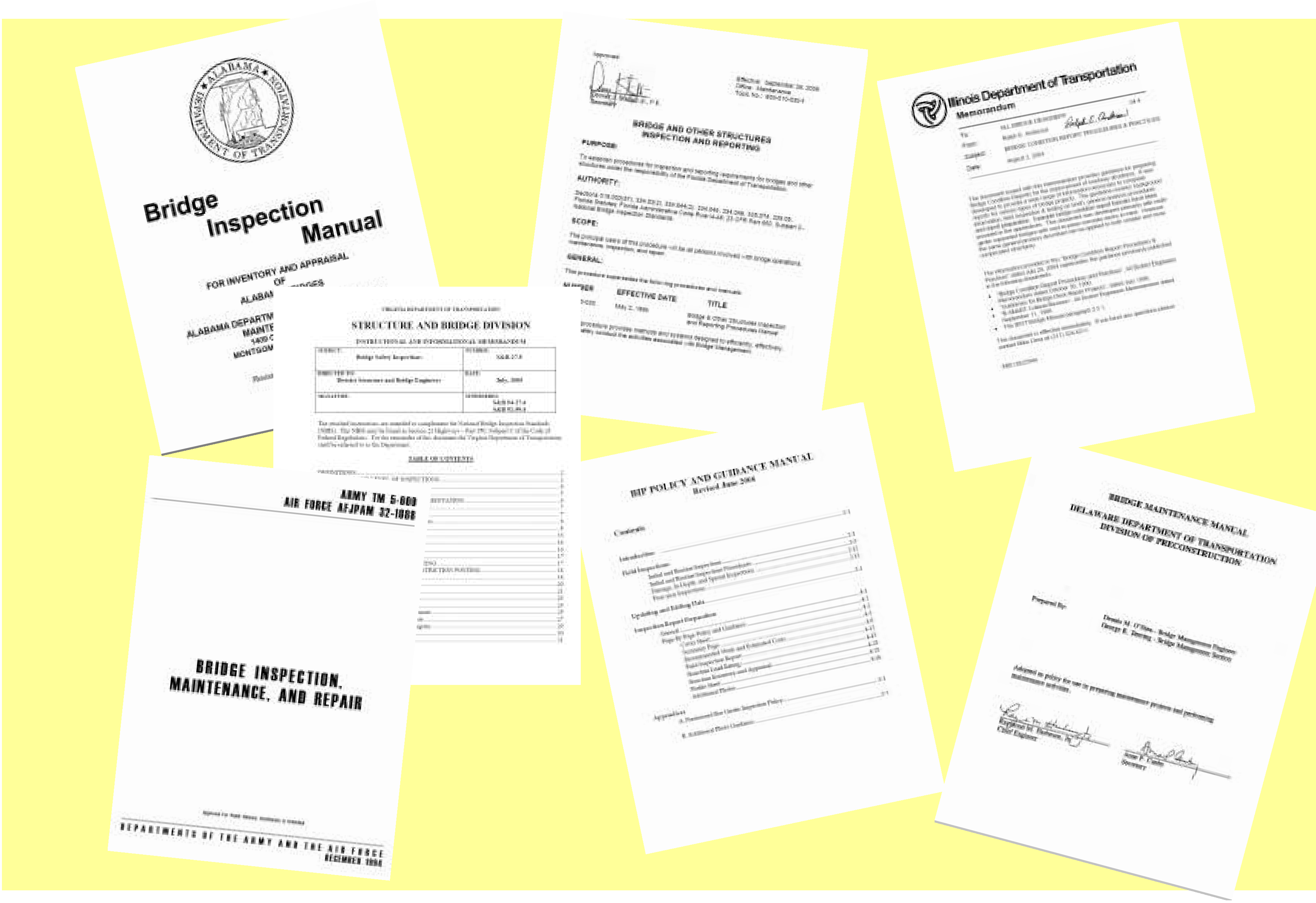
Malcolm T. Kerley
Chief Engineer
Virginia Department of Transportation
March 26, 2009

Synthesis Report 375



Bridge Inspection Practices

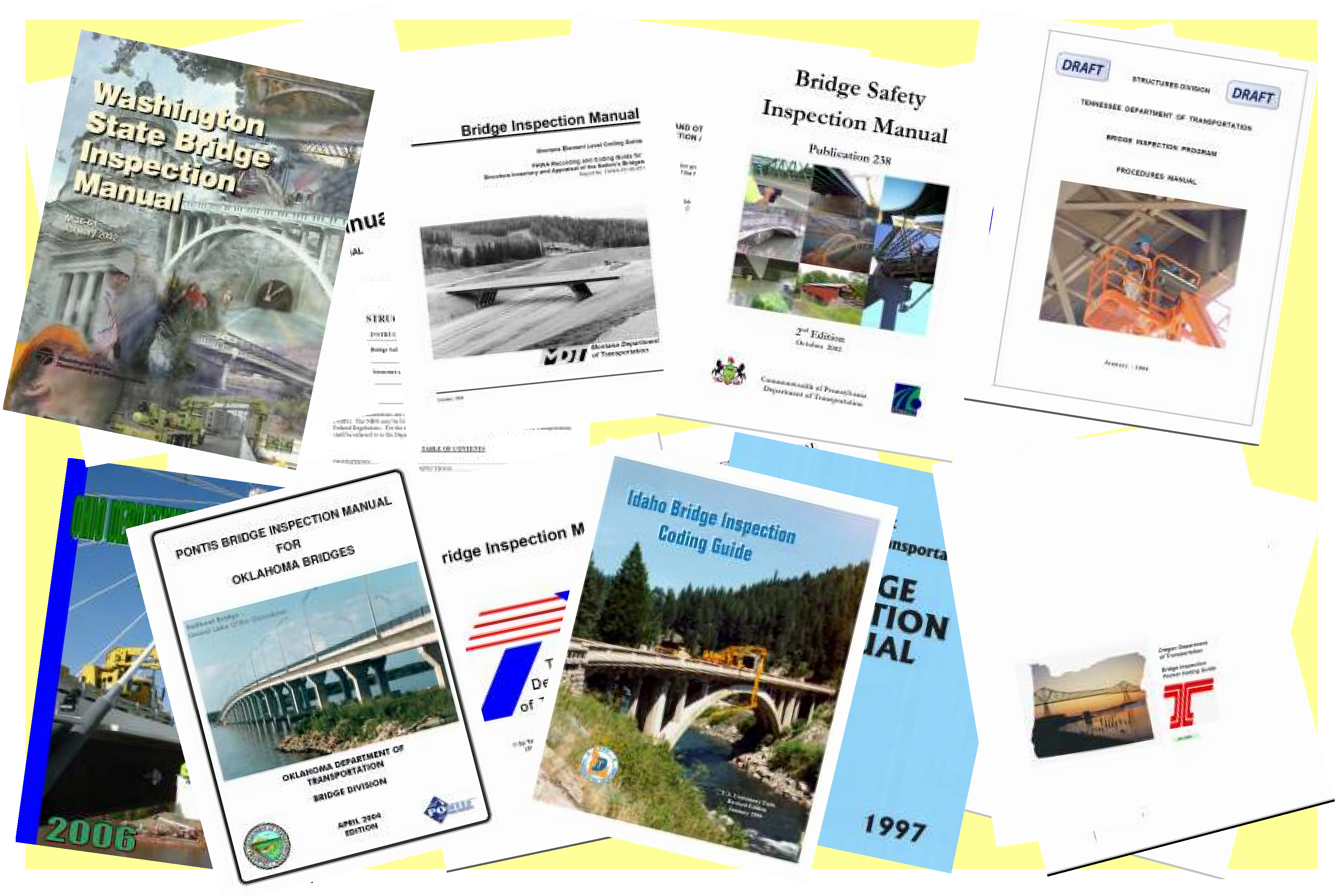
George Hearn


Bridge Inspection Manual
FOR INVENTORY AND APPRAISAL
STRUCTURE AND BRIDGE DIVISION
BRIDGE AND OTHER STRUCTURES INSPECTION AND REPORTING
PURPOSE:
AUTHORITY:
SCOPE:
GENERAL:
Illinois Department of Transportation
Memorandum
ARMY TM 5-600
AIR FORCE AFJPAM 32-1088
BRIDGE INSPECTION, MAINTENANCE, AND REPAIR
BIP POLICY AND GUIDANCE MANUAL
BRIDGE MAINTENANCE MANUAL
DELAWARE DEPARTMENT OF TRANSPORTATION
DIVISION OF PRECONSTRUCTION


RECORDING AND CODING GUIDE FOR STRUCTURE INVENTORY AND APPRAISAL OF NEW JERSEY BRIDGES
Minnesota Department of Transportation
BRIDGE INSPECTION MANUAL
CONNECTICUT DEPARTMENT OF TRANSPORTATION
BRIDGE INSPECTION MANUAL
SEPTEMBER 2001
OHIO DEPARTMENT OF TRANSPORTATION
Manual of Bridge Inspection
2006
Bridge Inspection Manual
Texas Department of Transportation
State of New York Department of Transportation
BRIDGE INSPECTION MANUAL
1997
ELEMENT LEVEL INSPECTION MANUAL

Method

Synthesis Report 375



Transportation Agencies

Danish Road Directorate

Statens vegvesen

TIEHALLINTO
FINNISH ROAD ADMINISTRATION

THE SOUTH AFRICAN NATIONAL ROADS AGENCY LTD

LCPC Laboratoire Central des Ponts et Chaussées

Vägverket

bast

HIGHWAYS AGENCY

Personnel

Federal	Program Manager	Comprehensive Training PE or 10 years experience
	Load Rater	PE
	Team Leader	Comprehensive Training Certification or Experience
States	Program Manager	Comprehensive Training PE +10 years experience
	Load Rater	PE + Training
	Team Leader	Comprehensive Traning Certification + Experience

Denmark
Engineer +
Annual Training

Finland
Engineer +
Annual re-certification

France
Engineer +
Training

Germany
Engineer +
Experience +_Training

Norway
Regional Engineer

South Africa
PE

Sweden
Engineer +
Training

United Kingdom
Chartered Engineer

Inspections

Damage	Unscheduled, to assess structural damage
Fracture critical	24 months
Hands-on	Within arms length of component
In-depth	Close-up, to identify deficiencies
Initial	SI&A data, baseline conditions
Routine	24 months
Special	Discretion of the bridge owner
Underwater	60 months

	Intervals		
	Short	Normal	Long
Routine	11%	84%	5%
Fracture Critical	26%	67%	7%
Underwater	66%	34%	< 1%

Oregon - Timber Boring Report

96 months	West of the Coast Range Service > 20 years
120 months	Western Oregon Service > 25 years
144 months	East of the Cascades Service > 30 years

Iowa - Access for Routine Inspection

Limited	24 months	Bridges in good condition, Not fracture critical.
Regular, Close-up	72 months	Bridges getting Limited inspections

Pennsylvania - Close Up

- Vulnerable / poor condition areas
- No hands-on inspection in 72 months
- Load carrying members in poor condition
- FC member < 10 years remaining life
- Redundancy retrofit systems
- Scour critical substructure units
- Ends steel girders under deck joint
- Cantilever concrete piers in fair or lesser condition
- Precast concrete bridge parapets

Underwater Inspection

Alabama	24 months	State-owned bridges
	48 months	Local-owned bridges
New York	60 months	General recmd. 4+
	24 months	General recmd. 3
	12 months	Active flag General recmd. 1 or 2

Interim Inspection

Florida	6 months	Condition rating = 3
	12 months	Condition rating = 4
Michigan	9 months	Substructure condition rating = 3 Hi Load Hit - rebar exposed Weakened by deterioration Loss of bearing at 2 adjacent beams Temporary supports for beams
	15 months	Substructure condition rating = 4 Main rebar exposed Shear cracks Beam exhibits lateral movement Loss of bearing / spall

48-Month Routine Inspection

Connecticut	In service four years Had in-depth inspection Condition ratings 6 or better HS 30 inventory rating Single span < 100 ft span < 75 years old 14' vertical clearance ADT < 125000 ADTT < 10%

Minor Structures

Pennsylvania	24 months	Non-bridge over highway Bridge spans 8 to 20 ft. Noise walls. Misc. structures Retaining walls. Sign structure
Washington	60 months	Highway lids Pedestrian bridges
	72 months	Bridge spans 6 to 20 ft
	24 months	Tunnels

Inspections

International

Denmark	Daily	-
	Routine	Annual
	Principal	6 years
Finland	Annual	1 year
	General	5 years
	Large Bridges	8 years
	Basic	5 years
	Machinery	1 year
	Cables	15 years
	Underwater	5 years

France	Routine	-
	Annual	-
	IQOA	3 years
	Detailed	6 years
	Underwater	6 years
Germany	Superficial	3 months
	Minor test	3 years
	Major test	6 years
	Underwater	6 years
Norway	General	1 years
	Major	5 years

South Africa	Monitoring Principal Verification	1 year 5 years ~60 / year
Sweden	Regular Superficial General Major Underwater	- 1 year 3 years 6 years 6 years
United Kingdom	Superficial General Principal Underwater	- 2 years 6 years 6 years

Inspectors
&
Inspections

United States	Team Leader	All
Denmark	Bridge Inspectors Road Foreman Roadmen	Principal inspection Annual inspection Daily inspection
Finland	Certified Inspector* Certified Inspector Road Foreman	Basic inspection General inspection Annual inspection
France	Certified Inspector Inspection Agent Maintenance Agent	Detailed inspection IQOA Annual inspection

Germany	Bridge Inspector Maintenance Crew	Major Test, Minor Test Superficial inspection
South Africa	Senior Inspector Bridge inspector Maintenance Crew	Verification inspections Principal inspection Annual inspection
Sweden	Bridge inspector Maintenance Contr	Major inspection
United Kingdom	Supervising Engr Bridge Inspector	Principal inspection General inspection

Condition Ratings

Germany - Condition Ratings

Rating	Strength	Traffic Safety	Durability
0	No effect	No effect	No effect
1	Adequate	Adequate	Adequate
2	Little effect	Slight effect	Some loss
3	Affects	Affects	Repair needed
4	Posted	Restricted	Lost

	Scale	Categories
Denmark	0 - 5	Damage
Finland	0 - 4	Condition, Repair, Damage
France	1-3, S	Condition, Urgency
Germany	0 - 4	Strength, Traffic Safety, Durability
Norway	1 - 4	Strength, Traffic Safety, Cost, Aesthetics
South Africa	0 - 4	Degree, Extent, Relevancy, Urgency
Sweden	0 - 3	Condition, Function, Cost
United Kingdom	1 - 5 A - E	Condition, Extent

QC / QA

Quality Control

US DOTs	Office review of reports
	Senior personnel for critical findings
	Visits to teams in field
	Verification inspections

Quality Assurance

US DOTs	Office review of programs
	Timely execution & response
	Workshops & Training
	Field verification exercises

International

	Dk	Fn	Fr	Gr	Nr	SA	Sw	UK
Report Review	Y	Au	ISO				Y	Y
Prior Compare	Y							
Training	Y	Y		Y		Y		
Field Evaluation	Y	Y		Y				
Verification						Y		Prj

Comparison

Inspection Intervals

	US	Dk	Fn	Fr	Gr	Nr	SA	Sw	UK
-		Daily		Rout.	Supfcl				Supfcl
1 yr		Rout.	Annual	Annual		Genl	Monit.	Supfcl	
2 yr	Rout.								Genl
3 yr				IQOA	Minor			Genl	
4 yr	Rout.								
5 yr			Genl			Major	Princ		
6 yr		Princ.		Detld	Major			Major	Princ
8 yr			Large						

Inspectors

	US	Dk	Fn	Fr	Gr	Nr	SA	Sw	UK
Not Certified		Rout.	Annual	Annual	Supfcl	Genl	Monit.	Supfcl	Supfcl
Certified	Rout.		Genl Large	IQOA Detld	Minor				Genl
Engineer		Princ.			Major	Major	Princ	Genl Major	Princ.

Access

	US	Dk	Fn	Fr	Gr	Nr	SA	Sw	UK
Drive By		Daily		Rout.					
Visible	Rout.	Rout. Princ.		Annual IQOA	Minor	Genl	Monit.	Supfcl Genl	Supfcl Genl
Arms Length			Genl Large	Detld	Major	Major	Princ	Major	Princ

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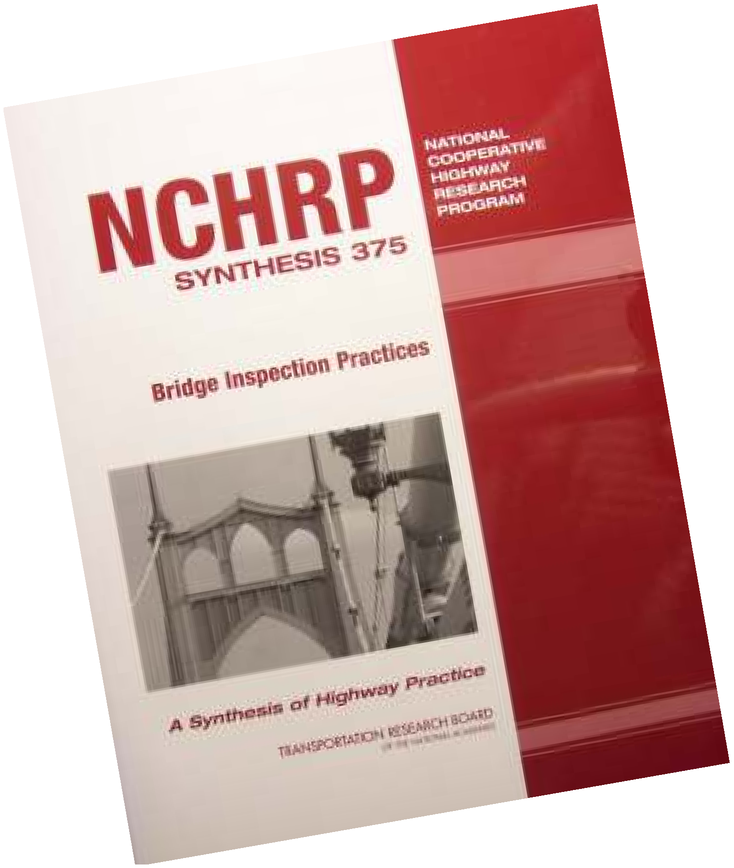

Bridge Inspection Practices

George Hearn

http://www.trb.org/news/blurb_detail.asp?id=8829

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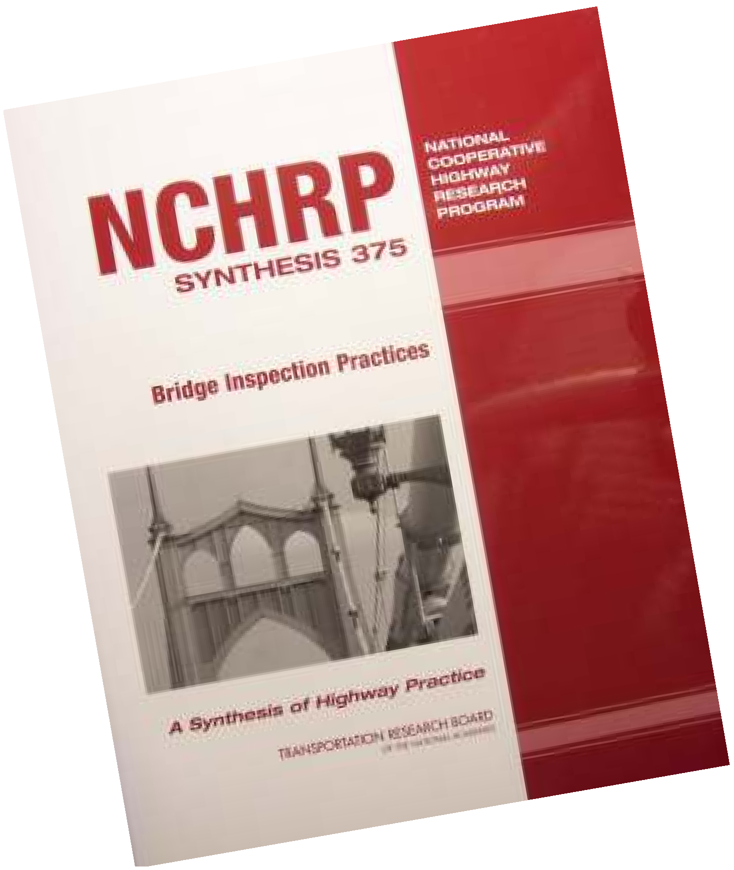

http://www.trb.org/news/blurb_detail.asp?id=8829

http://international.fhwa.dot.gov/links/pub_details.cfm?id=559

Inspection & Management of Bridges with Fracture-Critical Details (NCHRP Synthesis 354)

Robert J. Connor
Assistant Professor
Purdue University
March 26, 2009

PURDUE
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Objectives of Synthesis 354

- Survey & identify gaps in the literature
- Determine practices and problems with how bridge owners define, identify, document, inspect, and manage bridges with fracture-critical details
- Identify research needs

General Findings

- Very limited number of failures of FCB
- FCP seems to be working
  - But, relatively few FCB built since introduced
  - FCB comprise about 11% of US inventory
  - Majority (75%) built before 1975
- Field inspection is a <u>major</u> cost
  - Variability in inspection interval
  - Available training seems adequate
- Inconsistency in classification of FCBs

General Findings Cont'd

- Retrofit strategies have been developed
- If improved toughness of HPS steel can be utilized, data suggest that there is a potential to:
  - Eliminate special in-service inspection requirements for fracture critical structures for HPS steel
  - Reduce frequency and need for "hands-on" fatigue inspections for HPS steel
  - Eliminate of the penalty for structures with low redundancy for HPS steel

General Findings Cont'd

- Based on FHWA scanning tour:

  "Other countries have a more liberal view of the importance of redundancy. No special design, fabrication, or inspection requirements for such bridges were apparent. The U.S. design philosophy for nonredundant bridges should be reconsidered, based upon these observations and improvements in steel toughness."

Failures of FCB

- Only two known catastrophic failures of FC bridges
  - Silver Bridge
  - Mianus River
- Silver Bridge
  - Inspection would not likely have helped
- Mianus River
  - Material toughness not the issue

Failures of FCB

- Other fractures have been documented without catastrophic failure
  - Lafayette St, I-79 Neville Island, Hoan, SR 422, etc.
  - Bridge deflected, but in almost all cases could be repaired relatively easily

Failures of FCB

- Overall, there seems to be much redundancy in bridges traditionally classified as non-redundant

Still Standing

Fracture Critical vs. Redundancy

- “Fracture Critical” members are non-redundant (Failure Critical ??)
- Non-redundant is a broader term because it also includes:
  - Substructures
  - Members that may not be susceptible to fracture, such as:
    - compression members, but still could lead to collapse if damaged by overloading, earthquakes, fire, terrorism, ship or vehicle collisions, etc.; and,
    - members made of materials other than steel.

Three Types of Redundancy

- Internal Redundancy (Member Redundancy)
  - Member comprised of multiple elements. A fracture that formed in one element cannot propagate directly into the adjacent elements
- Structural Redundancy
  - External static indeterminacy and can occur in a two or more span continuous girder or truss
- Load-Path Redundancy
  - Internal static indeterminacy arising from having three or more girders or redundant truss members

Failure or Fracture Critical?

Inspection Costs

- Huge variation in the survey response
- Most agencies indicated increases between 200% and 500% for FCB
- Common reasons for increases:
  - Specialized access equipment
  - Rigging required for hands-on inspection
  - Traffic control to close lanes
  - Additional man-hours for hands-on inspection
  - More frequent use of NDT
  - Greater frequency of inspection for FCB
  - Cost to traveling public ????

Classification of FCB

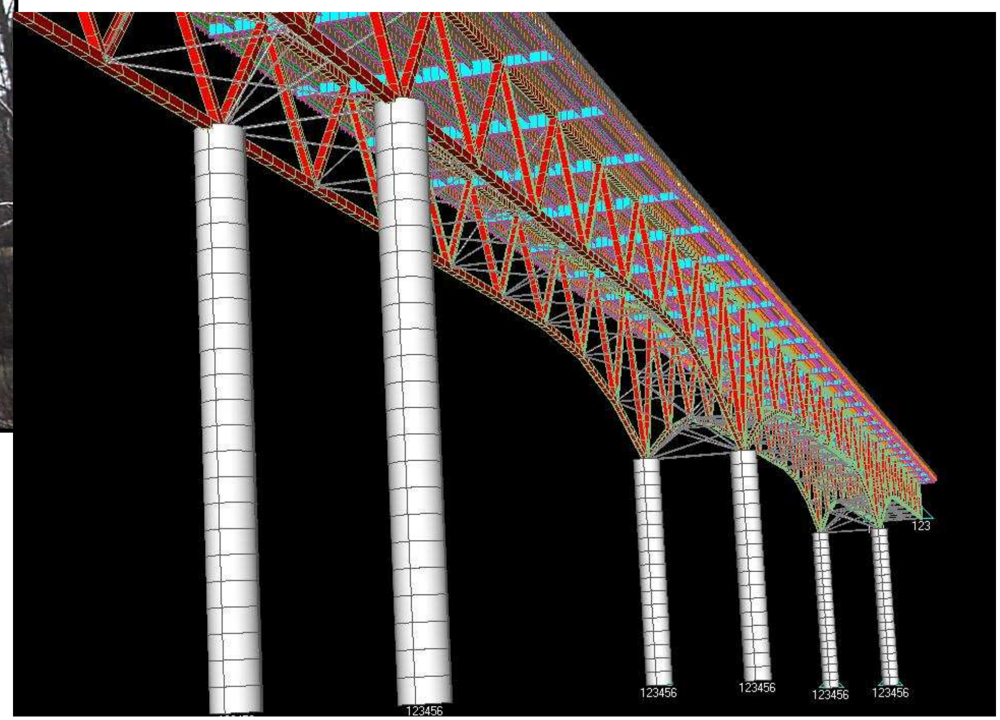
Considerable Variation in Responses

Structure Description	Fracture Critical	
	Yes	No
Two girder bridges	**38**	0
Three girder bridges	9	**28**
Three girder bridges with girder spacing > 15ft	10	**21**
Multi-girder bridges with girder spacing > 15ft	3	**32**
Truss bridges	**34**	3
Two girder bridges fabricated using HPS70W	**31**	1
Truss bridges fabricated using HPS70W steel	**28**	2
Single steel “tub” girder bridges	**32**	5
Twin steel “tub” girder bridges	**22**	12
Multi steel “tub” girder bridges	0	**34**
Other (post tensioned, timber, steel cross girders, etc.)	**13**	3

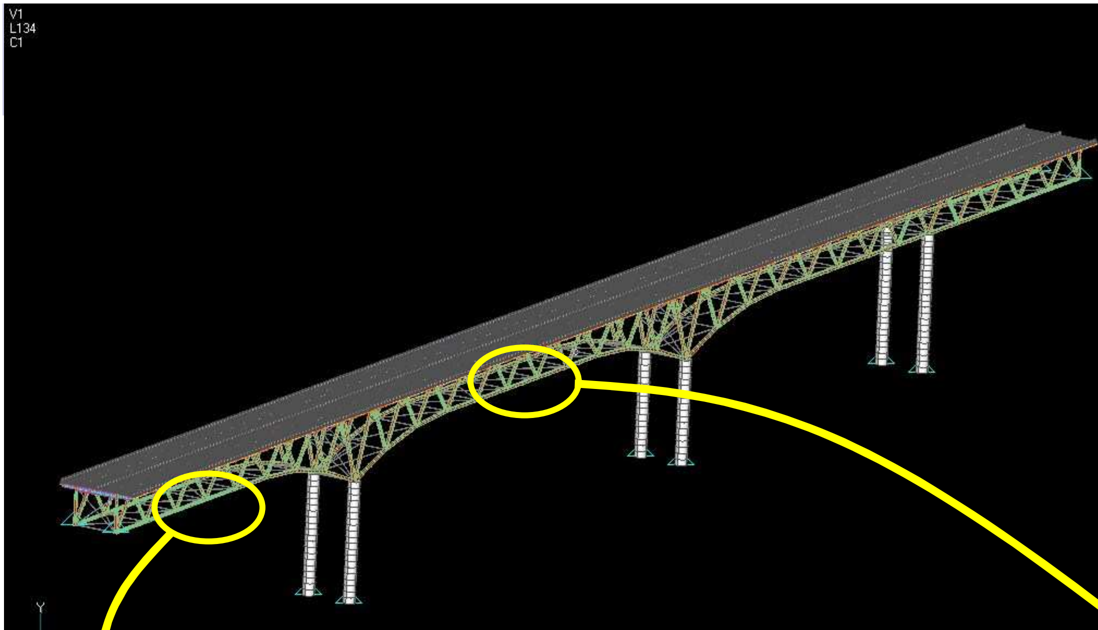
Designing and Retrofitting to Improve Redundancy

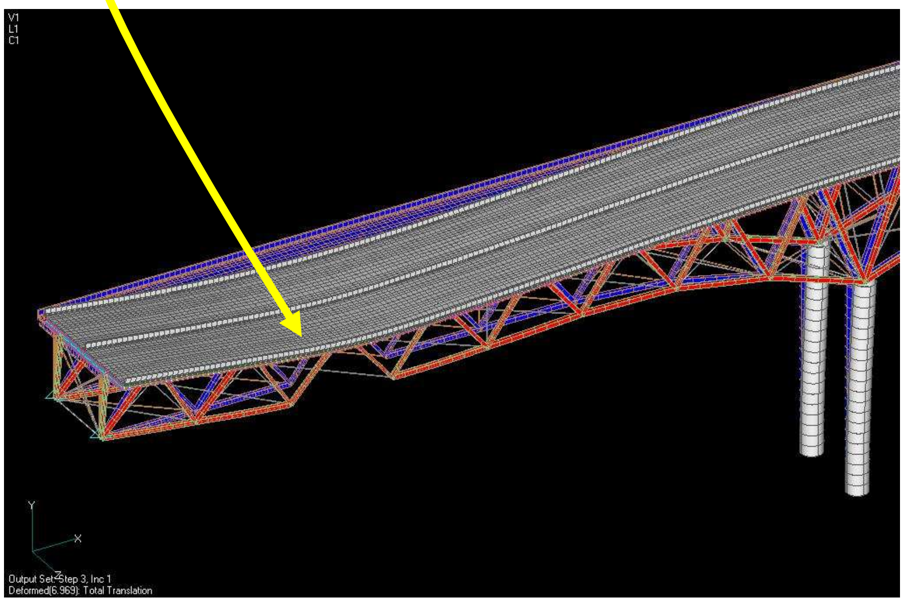
- Guidance needed on how to design new or evaluate existing bridges traditionally classified as FC to be non-FC
- Methods which have been used
  - Advanced analysis to demonstrate capable alternate load paths exist
  - Addition of components to improve internal member redundancy
  - Addition of supplementary members

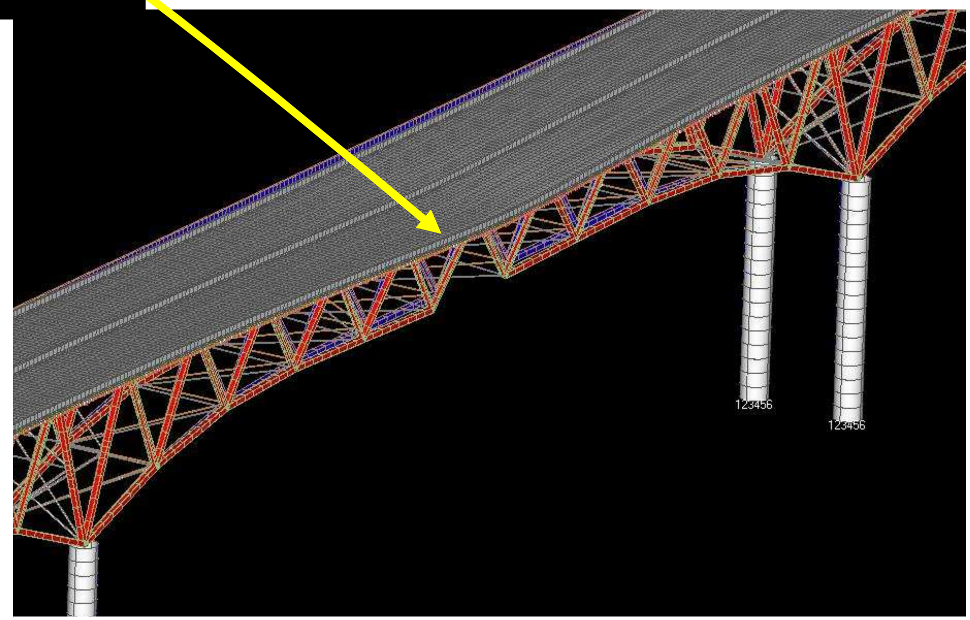
Utilization of Advanced Analysis Techniques



Advanced Analysis



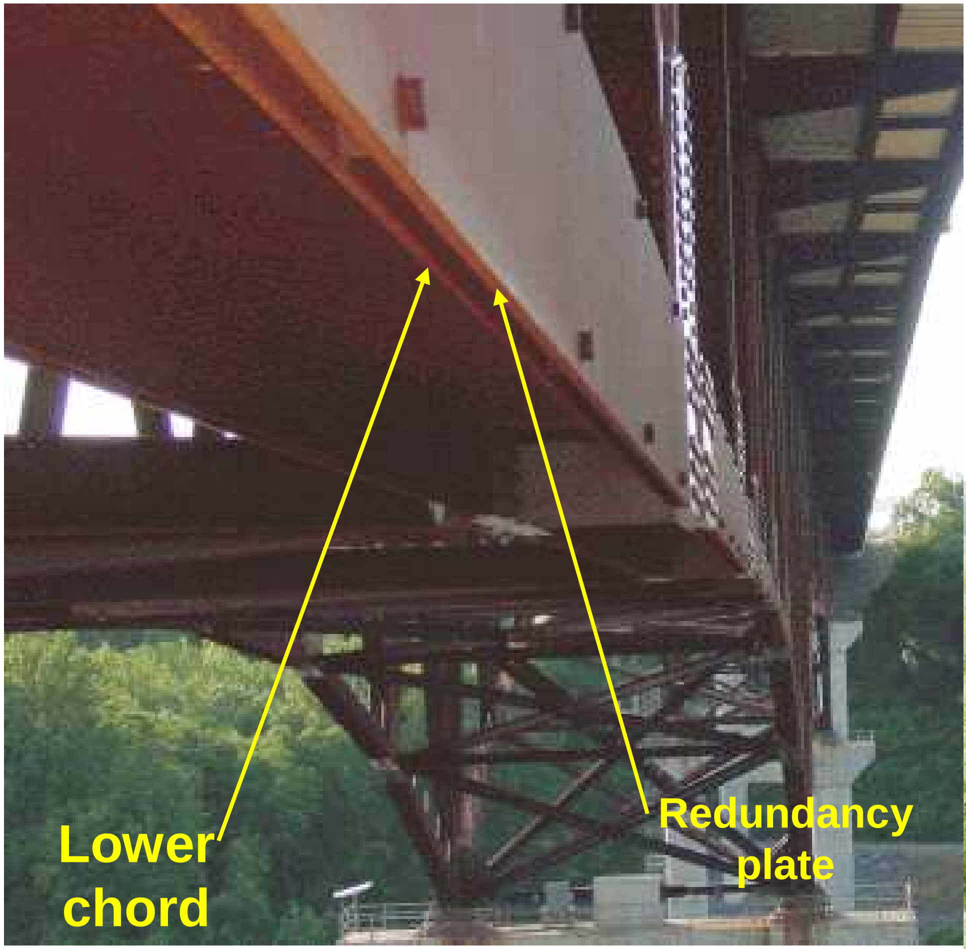




Various "what if" scenarios can be studied

Retrofit of Cross Girder

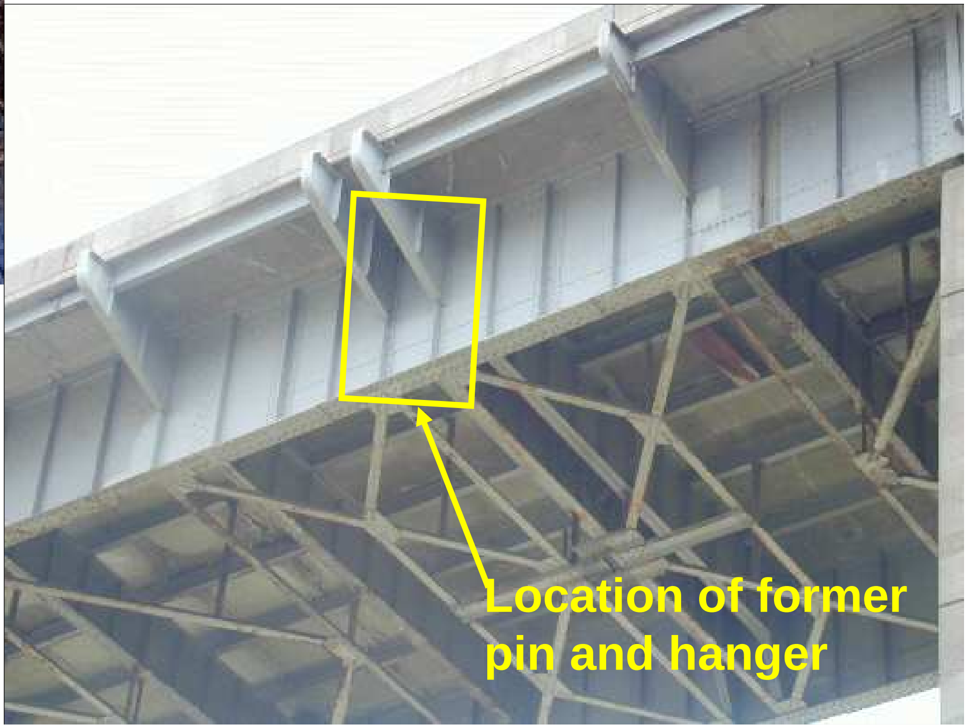
Addition of Redundancy Plates



In New Design

As a Retrofit

Pin and Hanger Retrofits



Post Tensioned Tied Arch Bridge

Identified Research Needs

Research Topic	Rank
Develop advanced analyses techniques and procedures to investigate alternate load paths, redundancy, and bridge collapse	**10**
Field monitoring for fracture critical bridges	**10**
Develop advanced fatigue-life calculation procedures taking into account lack of visible cracks for fracture critical bridges	**9**
Develop guidelines related to advanced structural analysis procedures to better predict service load behavior in fracture critical bridges	8
Establish evaluation procedures for advanced large deformation and member loss	7
Crack arrest capabilities of bridge steel	3
Develop rational inspection criteria related to inspection interval and level of detail on ADT, age, and fatigue detail categories present	2
Develop retrofit procedures to add redundancy	1

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http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_354.pdf

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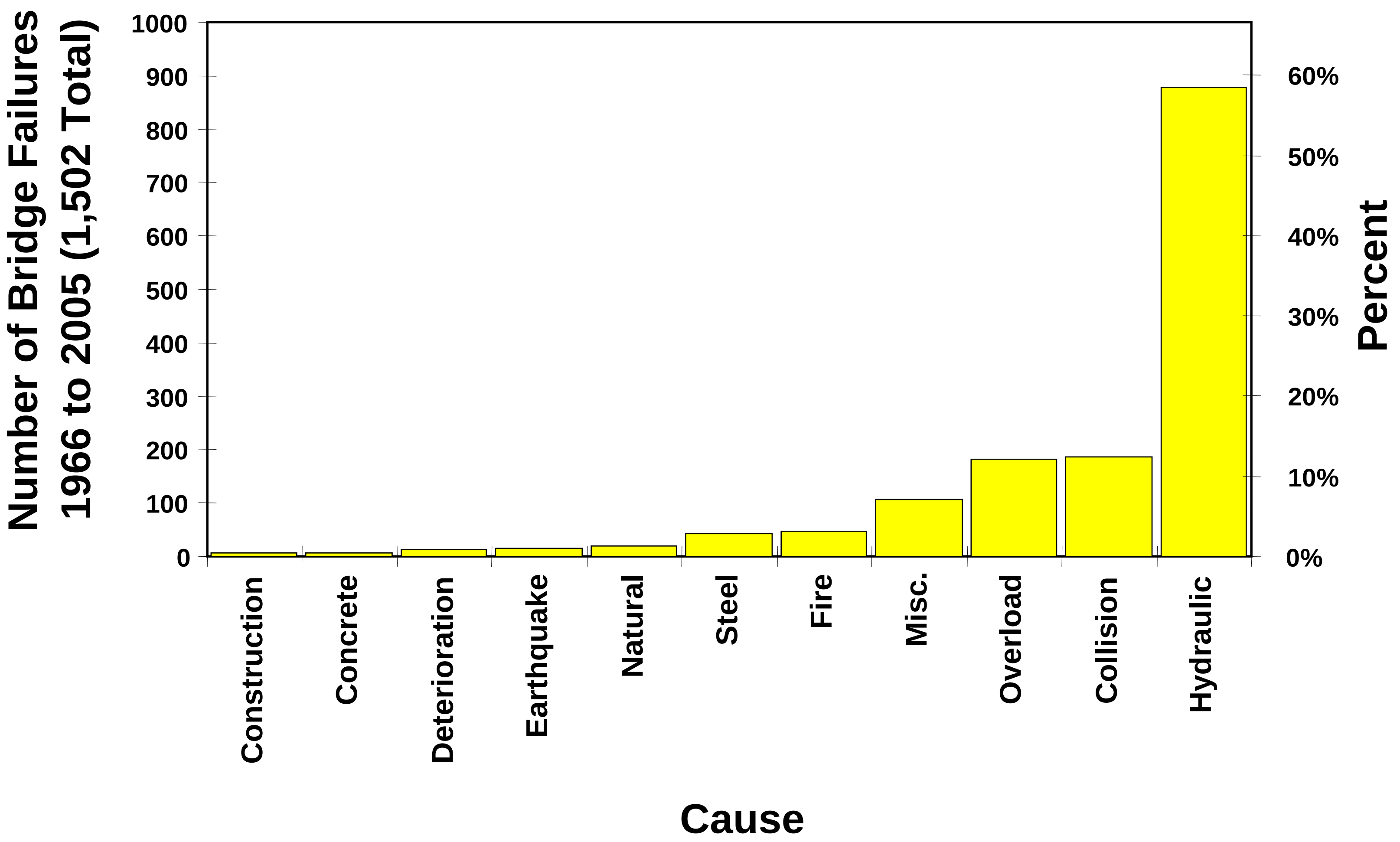
Monitoring Scour Critical Bridges (NCHRP Synthesis 396)

Beatrice E. Hunt, P.E.
Principal Hydraulic Engineer
STV Inc.
March 26, 2009

Outline

- Bridge scour and countermeasures
- Fixed scour monitors
- Scour monitoring practices
- Conclusions

Causes of Bridge Failures in the U. S.



Data courtesy of Mike Sullivan, NYSDOT
Figure courtesy of J-L Briaud, Texas A&M University

STV

NYS Thruway over Schoharie Creek

1987

Bridge Scour

- Approximately 60% of bridge failures in the U.S. are due to scour
- About 590,000 bridges in the National Bridge Inventory
  - Over 484,500 are over water
  - 20,904 have been declared scour critical

Scour Critical Bridge

A scour critical bridge is one with abutment or pier foundations rated as unstable due to the observed scour at the bridge site or scour potential as determined from a scour evaluation study.

FHWA Memorandum on "Revision of Coding Guide, Item 113 – Scour Critical Bridges" dated 04/27/01

NBIS - Code of Federal Regulations

Requirements for scour critical bridges:

"Prepare a plan of action to monitor known and potential deficiencies and to address critical findings. Monitor bridges that are scour critical in accordance with the plan."

23 CFR 650.313, Subpart C, September 13, 2005

STV

Scour Countermeasure Groups

- Hydraulic
- Structural
- Biotechnical
- Monitoring

FHWA Hydraulic Engineering Circular No. 23 (HEC-23), Third Edition

STV

Types of Scour Monitoring

- Portable Instrumentation
- Visual Monitoring
- Fixed Instrumentation

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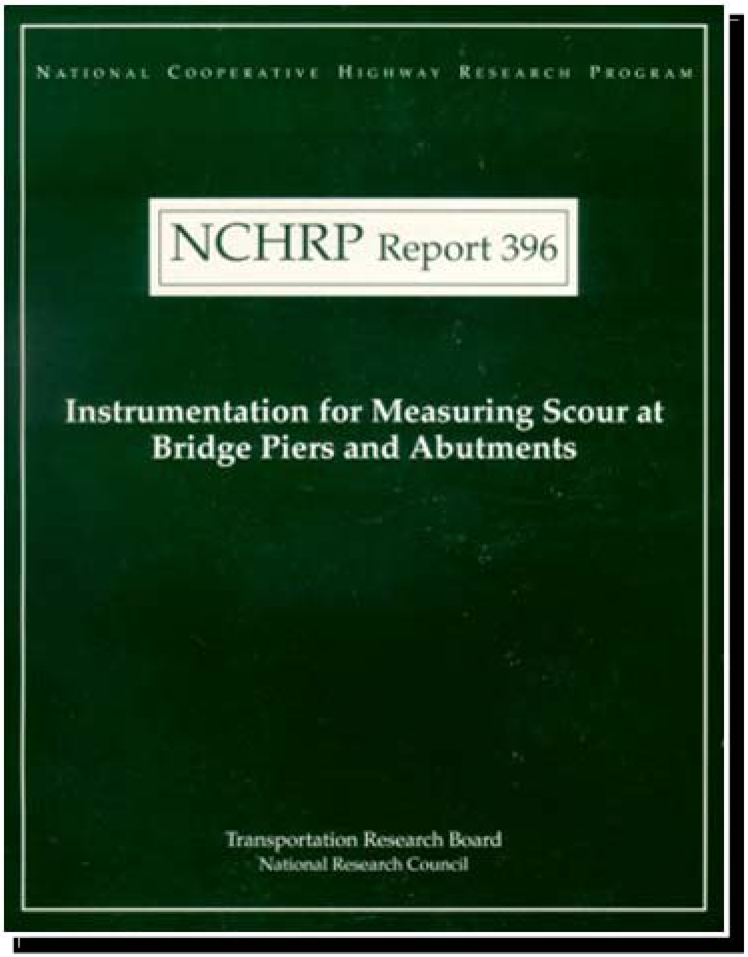
Guidance on Fixed Monitors

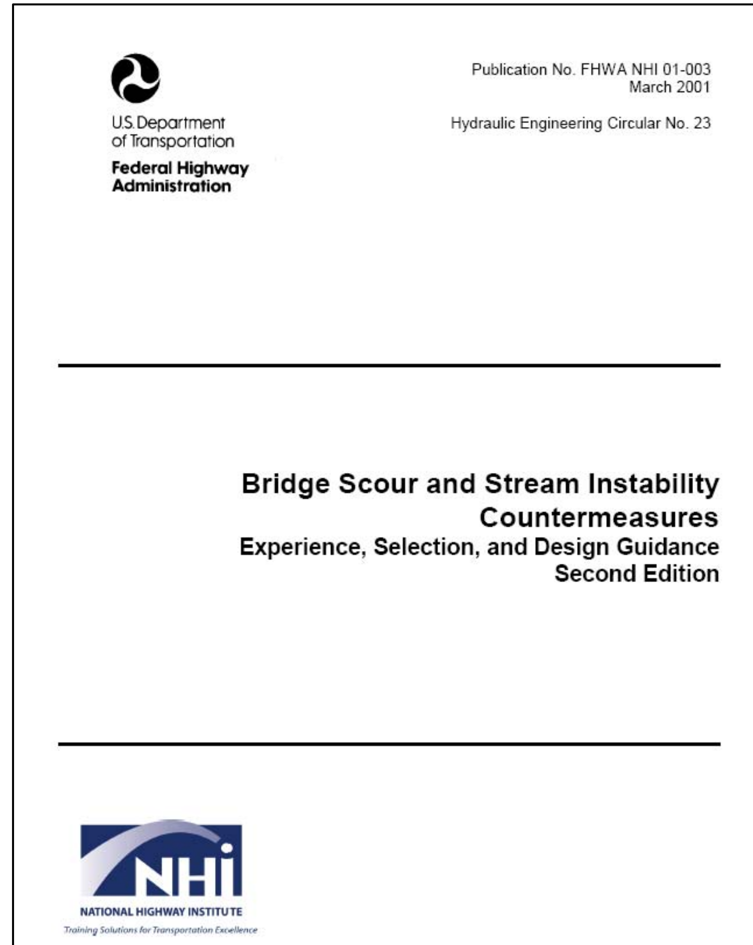

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP Report 396

Instrumentation for Measuring Scour at Bridge Piers and Abutments

Transportation Research Board
National Research Council

TRB NCHRP Report 396


U.S. Department of Transportation
Federal Highway Administration

Publication No. FHWA NHI 01-003
March 2001

Hydraulic Engineering Circular No. 23

Bridge Scour and Stream Instability Countermeasures
Experience, Selection, and Design Guidance
Second Edition

NHI
NATIONAL HIGHWAY INSTITUTE
Training Solutions for Transportation Excellence

FHWA HEC-23

Types of Fixed Scour Monitors

Sonar

Tilt Sensor

Time Domain Reflectometer

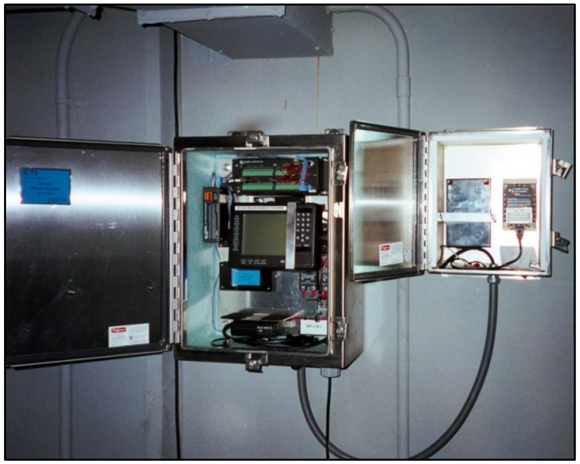
Magnetic Sliding Collar

Float-out

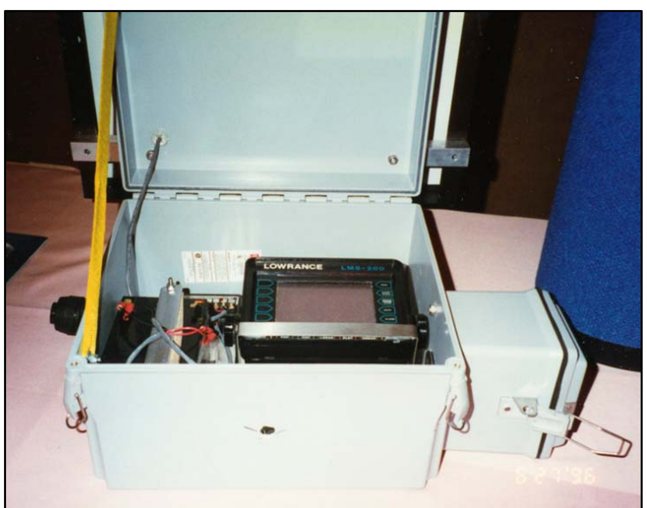
STV

Data loggers

Bridge Pier



Indoors – Pier Tower



Box for Bridge Railing

Nearby Building

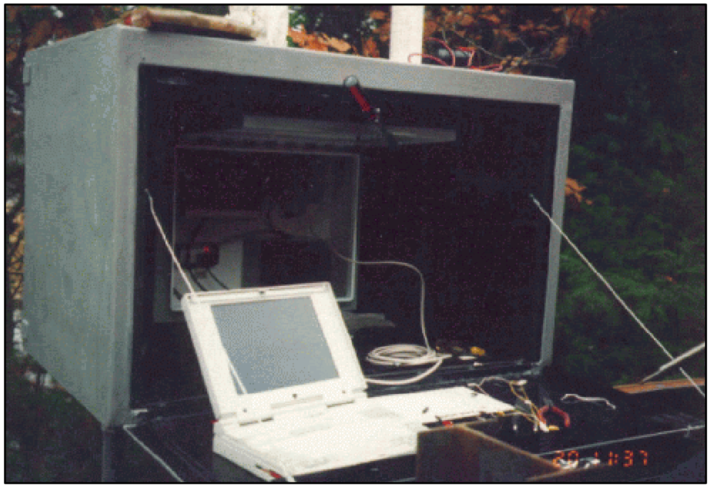
STV

Powering the System

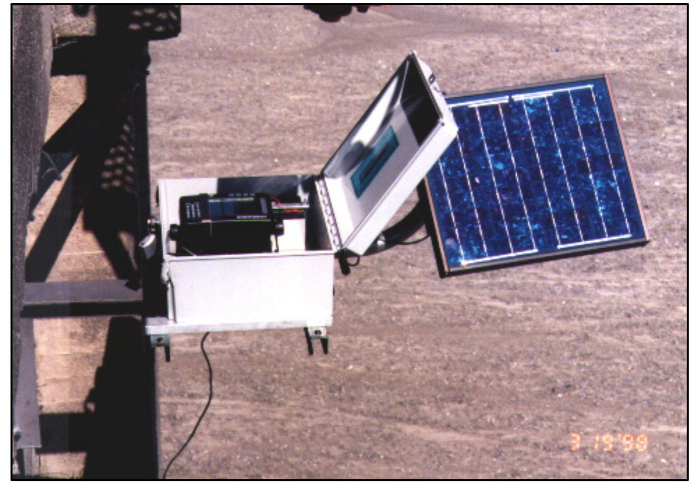
Commercial Power

Solar Power

Data Retrieval



On-site



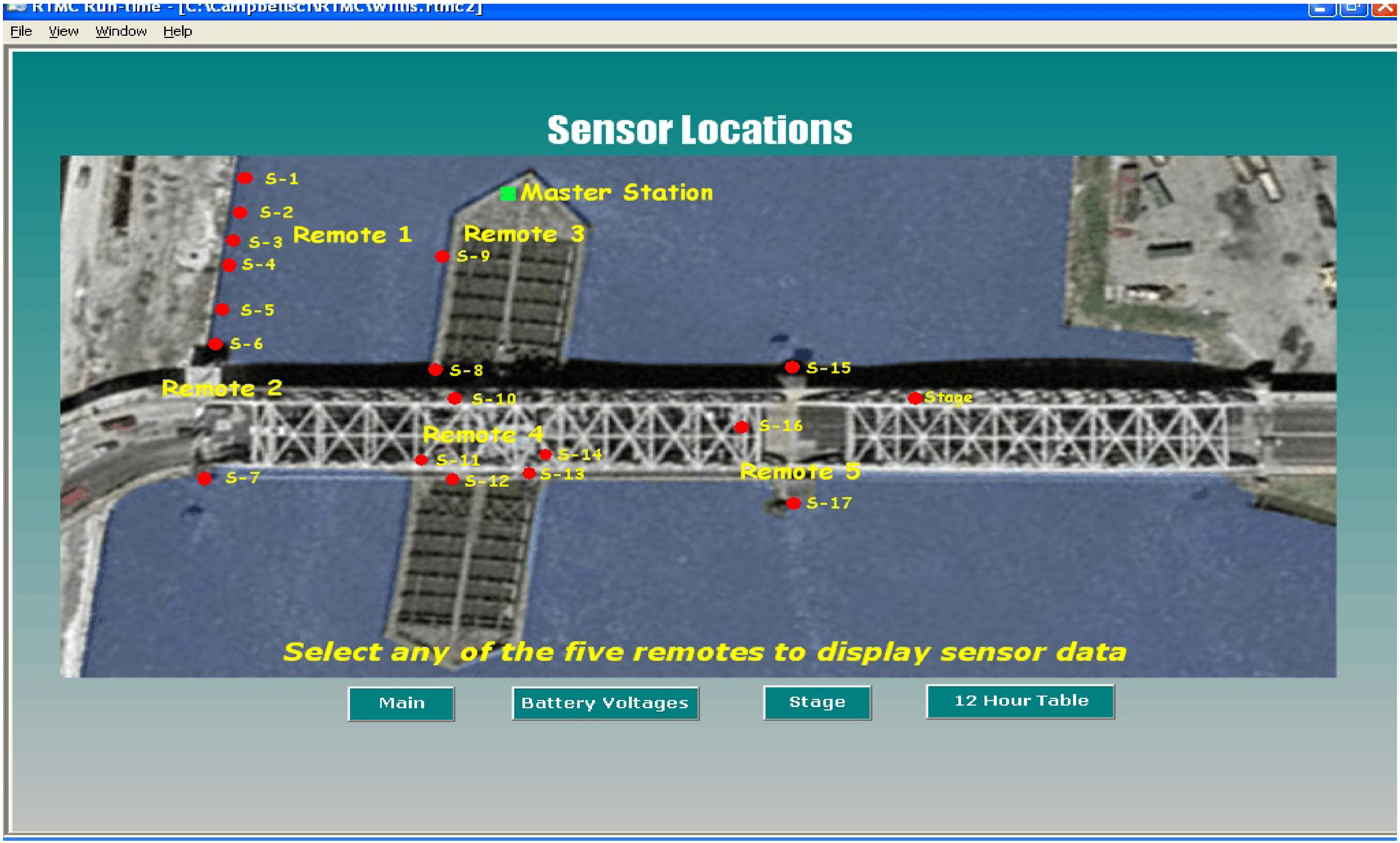
Telephone Land line

Satellite

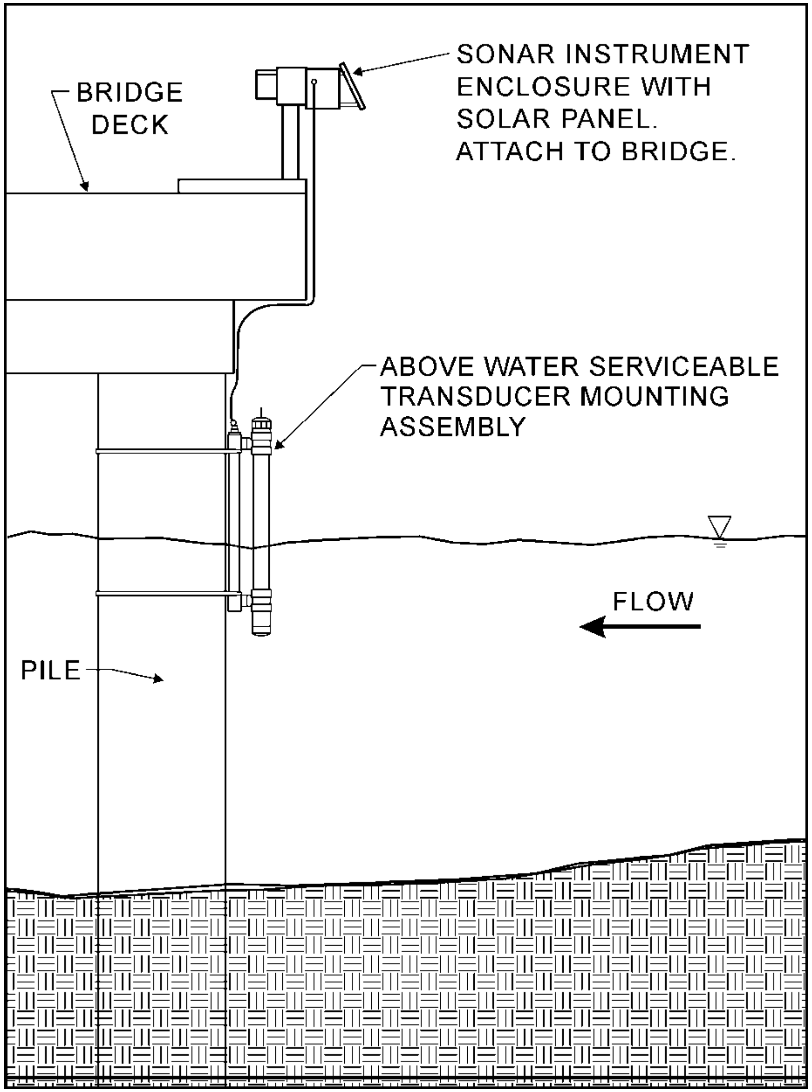
Cellular

STV

Internet Data Retrieval



Sonar Scour Monitors



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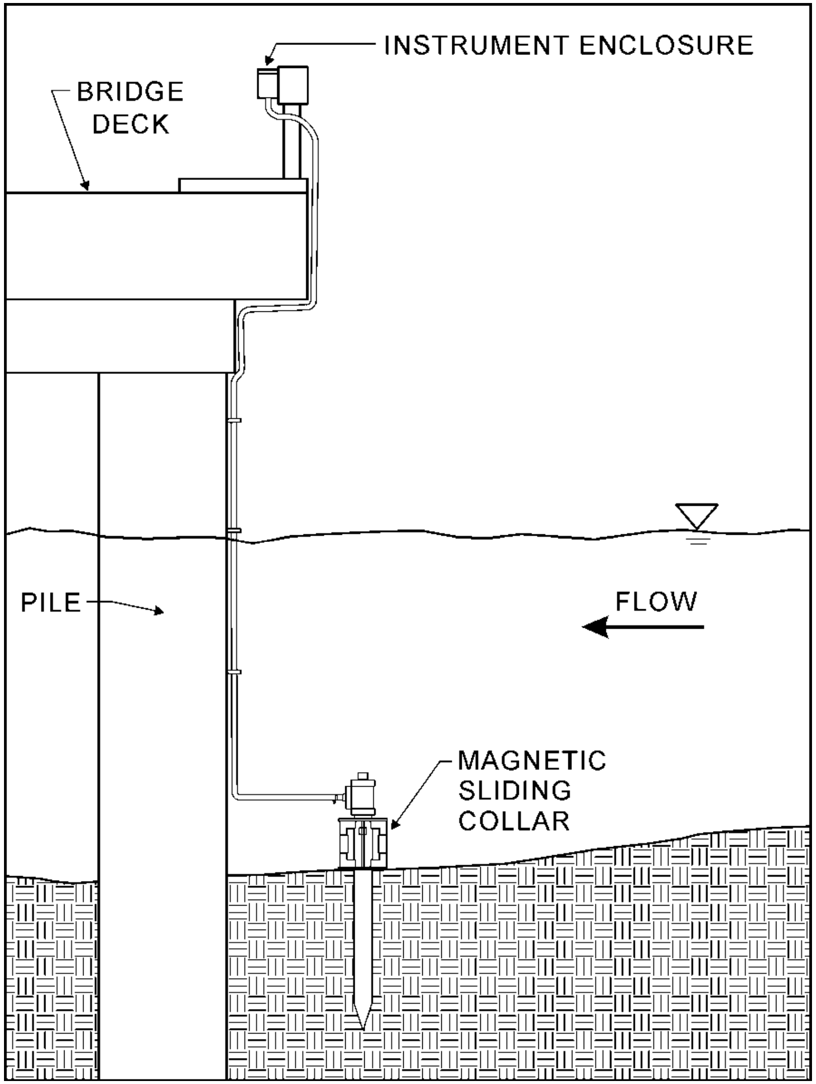
Magnetic Sliding Collars



FHWA HEC-23

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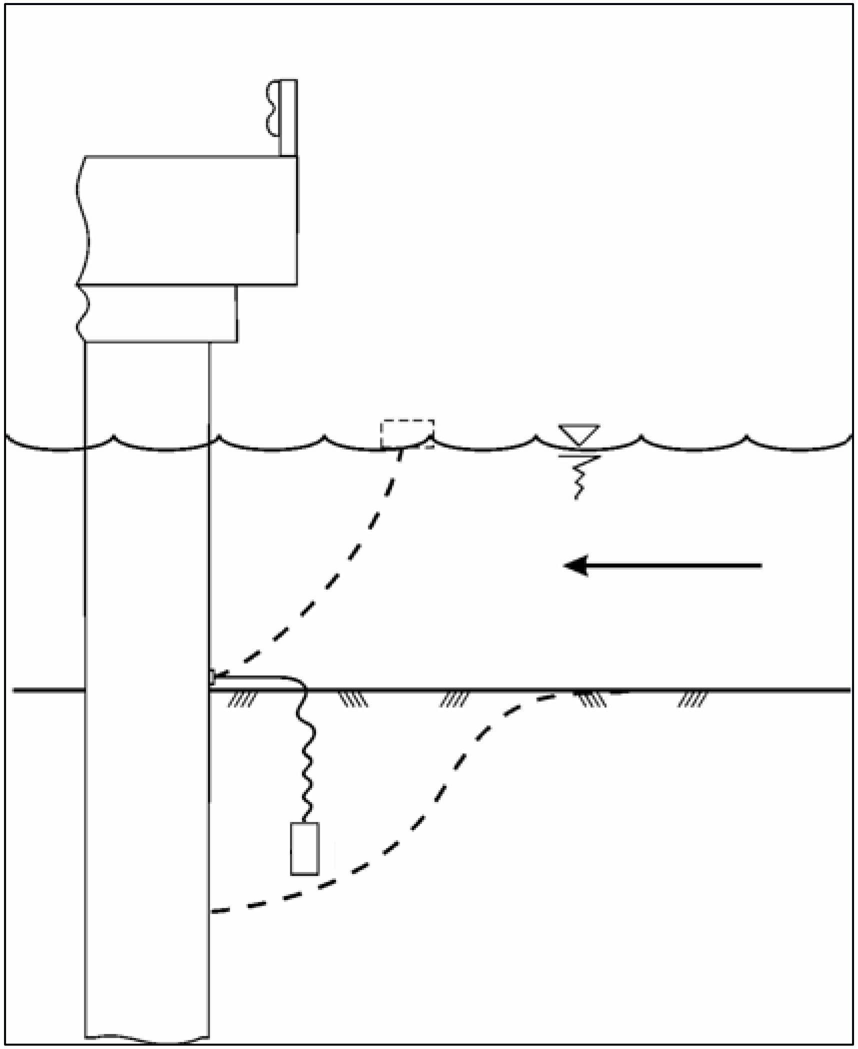
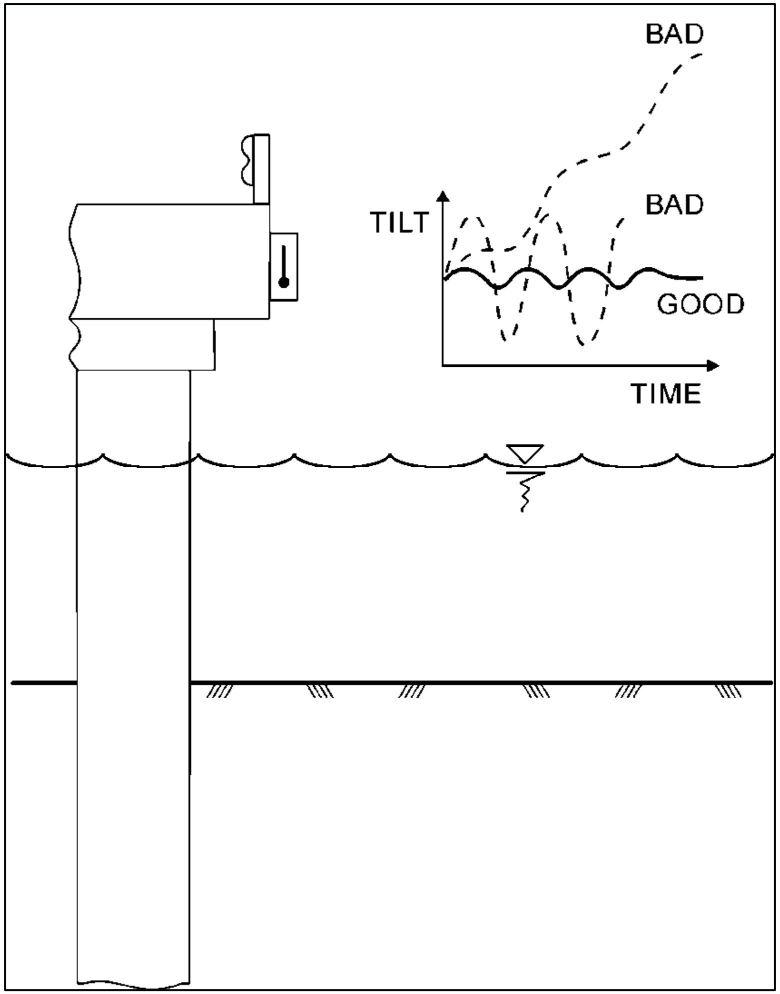
Float-out Devices



Texas A&M

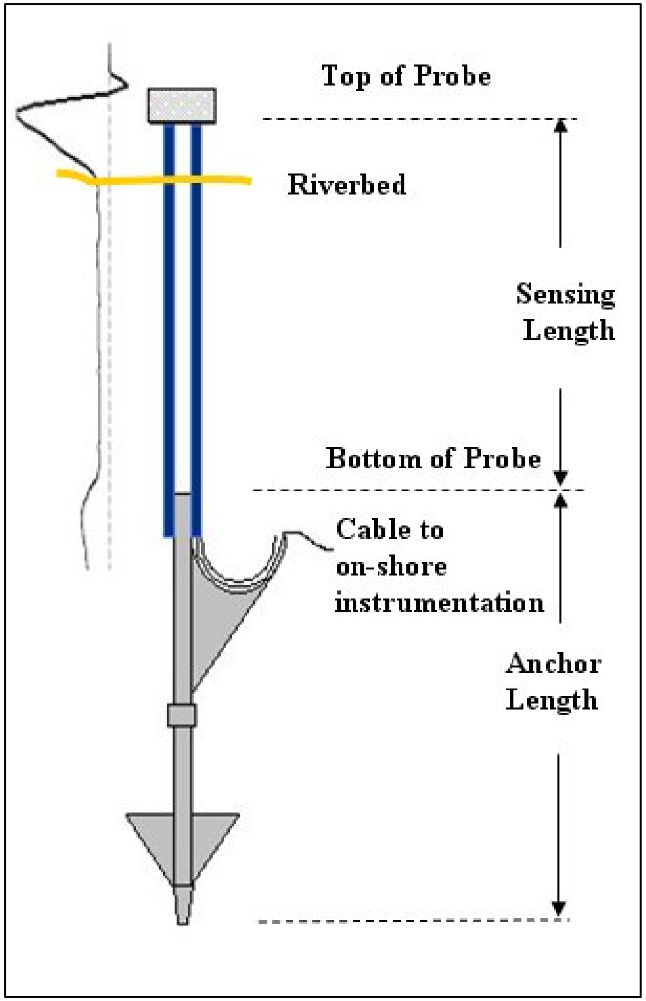
STV

Tilt Sensors

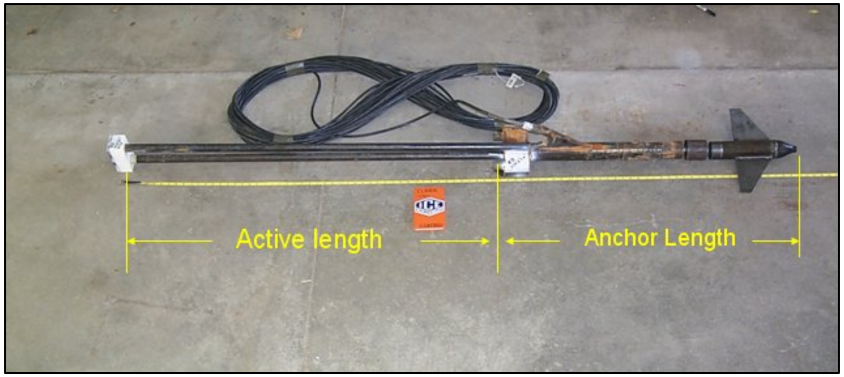


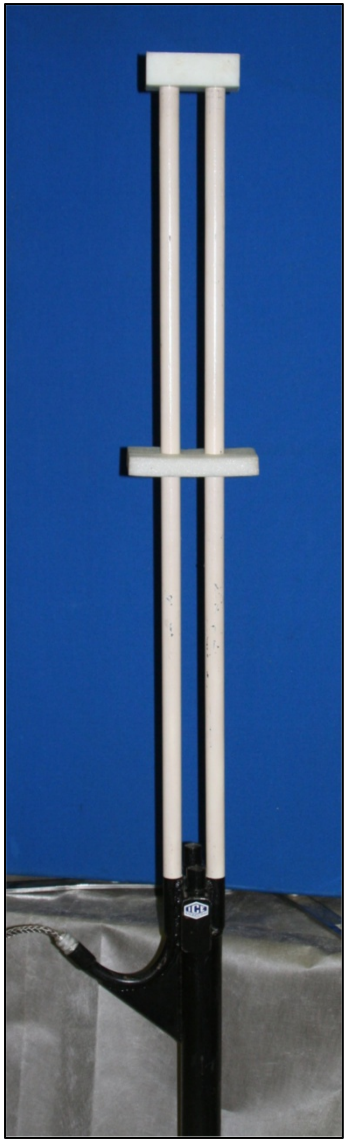
Texas A&M

Time Domain Reflectometers



CRREL, USCOE

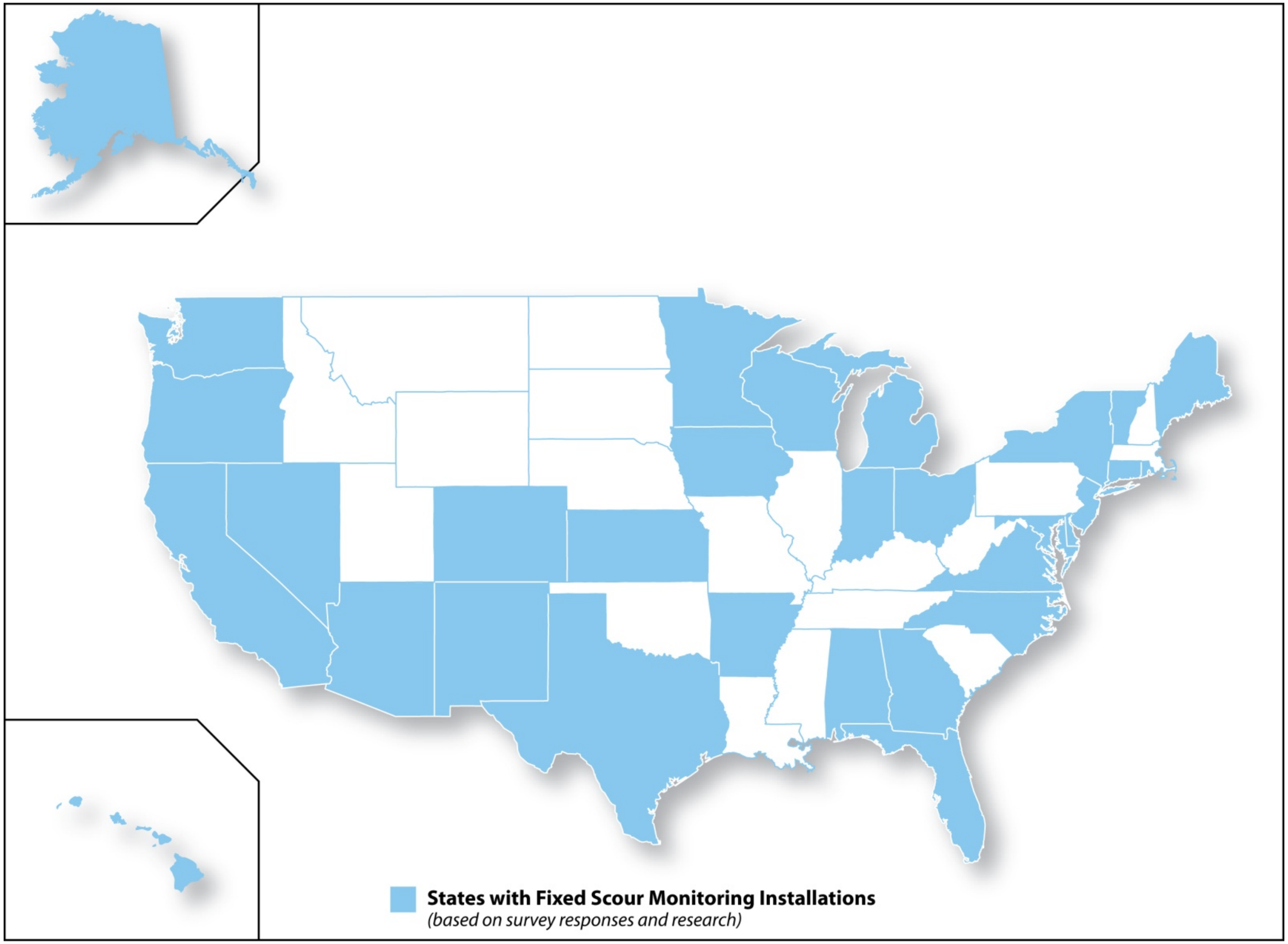




Use of Fixed Scour Monitors

- 33 states and the District of Columbia
- Over 120 bridges identified
- The majority reported a history of bridge scour or were scour critical by calculation

States with Fixed Scour Monitors



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New Hampshire
New Jersey
New Mexico
New York
North Carolina
Ohio
Oregon
Rhode Island
Tennessee
Texas
Vermont
Virginia
Washington
Wisconsin

Data Being Collected

- Streambed elevations
- Bridge movements

- Water Stage
- Velocity measurements
- Rainfall

STV

Bridge Information

- Average Daily Traffic (ADT) ranged from 100 to 175,000 vehicles per day
- Bridge lengths: 12.5 m (41 ft) to 3,921 m (12,865 ft)
- Bridges constructed between 1901 and 1988
- Monitors installed between 1991 and 2008 and some to be installed

Substructure Information

- 83% piers; 3% abutments; 8% other
- Foundations: 60% piles; 35% spread footings; 2% drilled shafts; 2% unknown foundations
- Problems cited:
  - Complex pier geometry
  - Lack of as-built plans
  - Installation on large or tall bridges

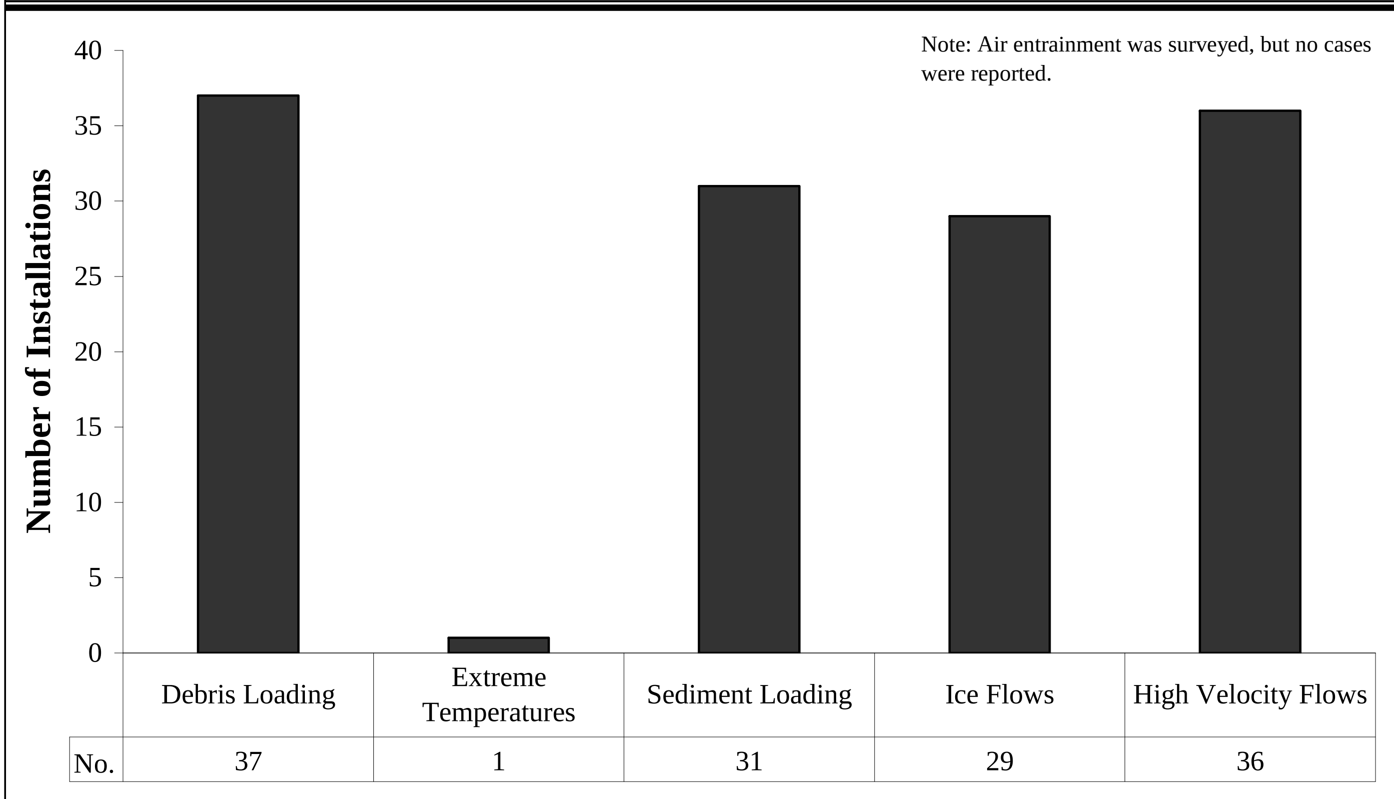
STV

Site Conditions

- Riverine and tidal
- Intermittant to perennial flows
- Water depths: < 3 m to 30 m (<10 ft to 75 ft)
- Soil conditions: clay, silt, sand, cobbles, gravel, organics, riprap, rock and concrete

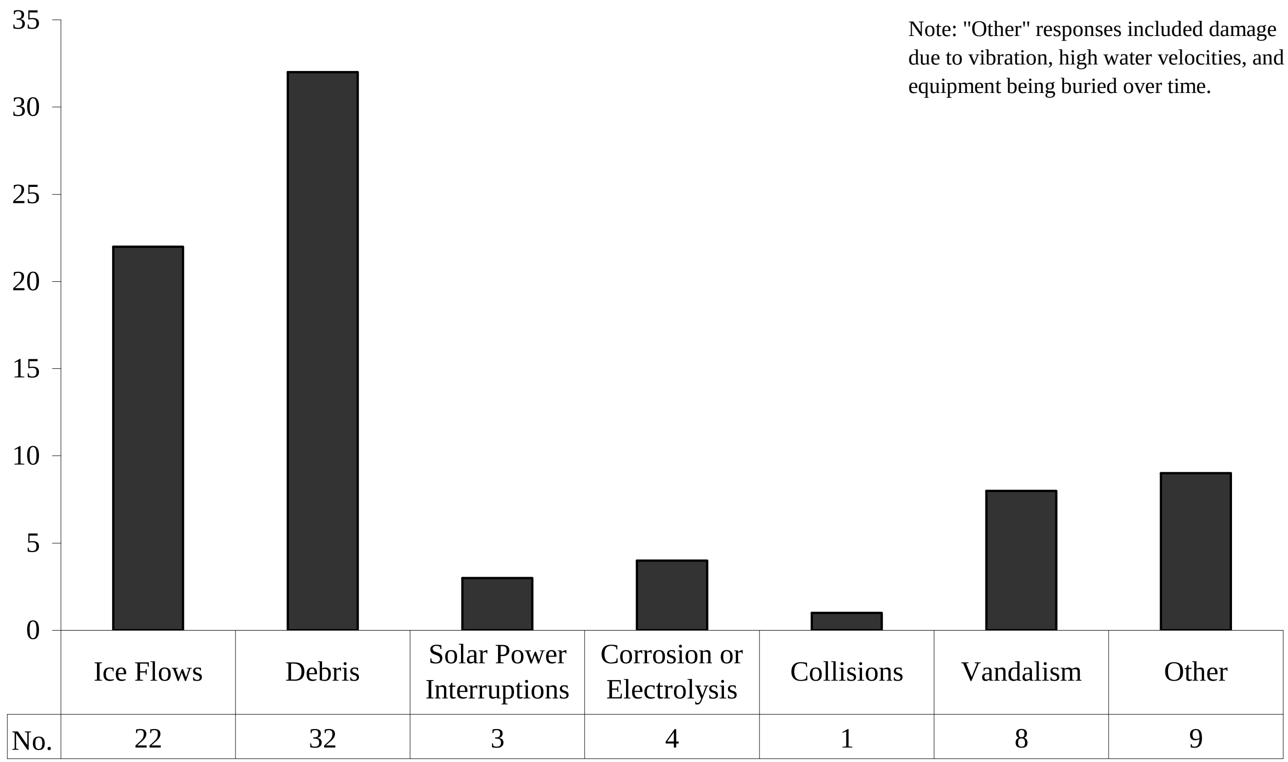
Extreme Site Conditions

Figure 20 Extreme Site Conditions at Scour Monitoring Locations



Interference and Damage

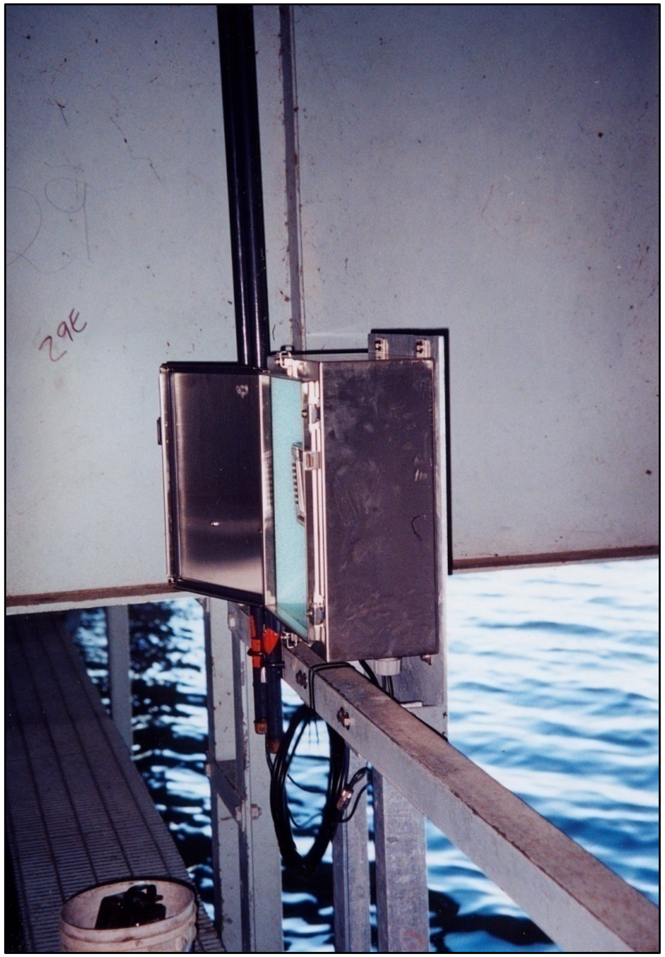
Figure 21 Site conditions that caused interference or damage to the fixed scour monitoring systems



Installation and Future Maintenance

STV

Heightened Security and Access



Original Woodrow Wilson Memorial Bridge

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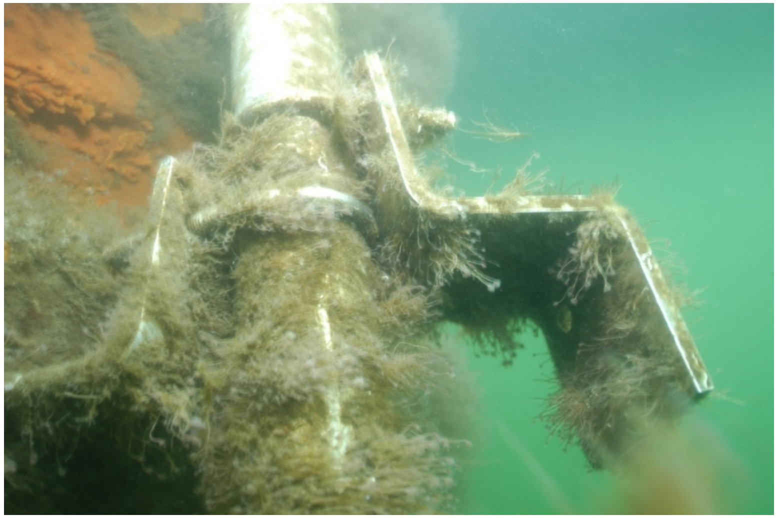
Diving Inspections & Maintenance



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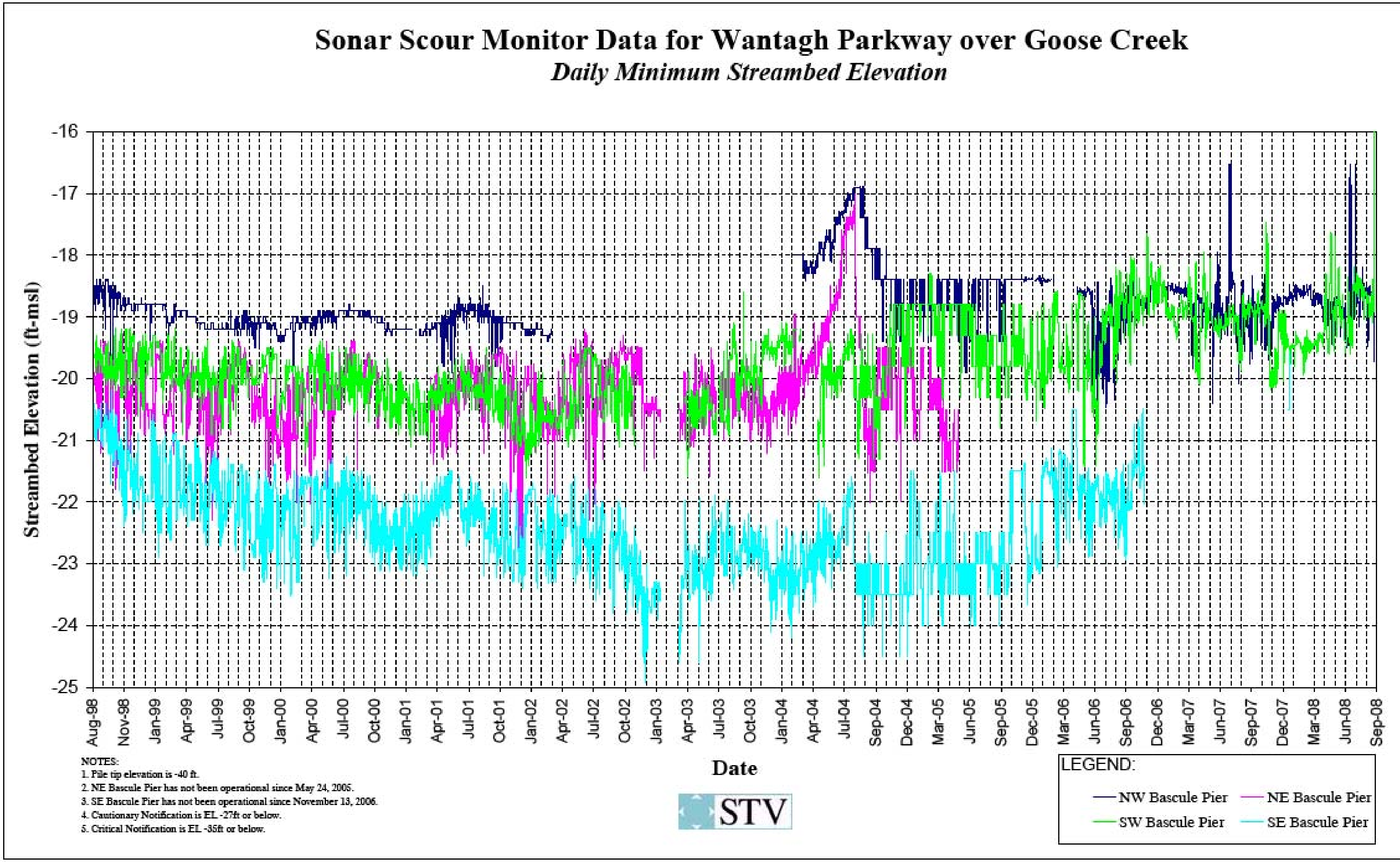
Scour Monitoring Data



Nassau County, New York
NYSDOT, Region 10

Oct 23, 2008
BIN 1- 05850-9

Fixed Instrumentation Selection Matrix

Table 9.6. FIXED INSTRUMENTATION SELECTION MATRIX
Countermeasure Characteristics

	FUNCTIONAL APPLICATIONS					SUITABLE RIVER ENVIRONMENT [2]													
	Local Scour		Contraction Scour	Stream Instability		Waterway Type		Flow Habit	Water Depth	Bed Material	Extreme Conditions	Foundation Type	Capabilities		Maintenance	Survey Respondents		Installation Experience	
Type of Fixed Instrumentation	Abutments [1]	Piers	Floodplain and Channel	Vertical	Lateral	Tidal	Riverine	E=Ephemeral I=Intermittant P=Perennial PF=Perennial/ Flashy	A = < 3 ft B = 10-30 ft C = 31-50 ft D = 51-75 ft E = 76-100 ft	F = Fine bed S = Sand bed C = Coarse bed R = Riprap	D=Debris T=Temperatures S=Sediment loads I=Ice flows V=High Velocity Flows	P=Piles SF=Spread Ftg DS=Drilled Shafts U=Unknown	Continuous Monitoring	Remote Technology	H = High M = Moderate L = Low	No. of Bridge Sites	No. of Instruments	Installation Experience by State from Surveys *(Note: States in **bold** have indicated they plan to use fixed instrumentation in the future)*	Additional Installation Experience by State Other Sources
Sonar	◗	●	●	●	◗	●	●	✓	✓	✓	T, I, V	✓	Yes	Yes	M - H	48	164	**AK**, AR, **CA**, **FL,** GA, **HI,** IN, KS, MD, NC, NJ, NV, **NY, TX, VA, WA**	CO, NM, OR, RI, WI
Magnetic Sliding Collar	●	●	●	●	◗	◗	●	✓	A, B	F, S, C	✓	✓	Yes	Yes	M	8	22	**CA, HI**, IN, **MN,** NJ, **NY**	CO, FL, ME, MI, NM, RI, TX, WI
Tilt Sensors	●	●	●	●	●	●	●	✓	✓	✓	✓	✓	Yes	Yes	L	4	35	**CA, WA**	
Float Out Device	●	●	●	●	●	○	●	E, I	A, B	F, S	✓	✓	No	Yes	L	3	35	AL, **CA,** NV	AZ
Sounding Rods [1]	◗	●	●	●	◗	◗	●	✓	A, B	C	T, S	SF	Yes	No	H	0	0		AR, IA, NY
Time Domain Reflectometers [1]	◗	●	●	●	●	○	●	P, PF	A, B	F, S, C	✓	✓	Yes	Yes	M	1	2	**VT**	

STV

Benefits of Scour Monitoring Systems

- Provides safety for the traveling public
- May provide a reduction in the number of required diving inspections and fathometer surveys
- Early identification of a problem prior to inspections
- Insight into site-specific scour processes
- One component of a comprehensive Plan of Action
- Appropriate for large bridges and deep water conditions

STV

Benefits of Scour Monitoring Systems

- May be quickly designed and installed
- Continuous monitoring of streambed elevations (sonars)
- Capable of measuring scour and infill conditions (sonars)
- May be used to extend the life of a bridge
- May be combined with other scour countermeasures
- Provide data useful for replacement bridges and scour research

STV

Future Needs for Scour Monitoring Technology

- More robust devices - increased reliability and longevity
- Decreased costs
- Less maintenance
- Devices more suitable for larger bridges
- Combine scour monitors with devices that measure additional hydraulic variables and/or structural monitors
- Funding for the scour monitoring program post-installation

STV

Conclusions

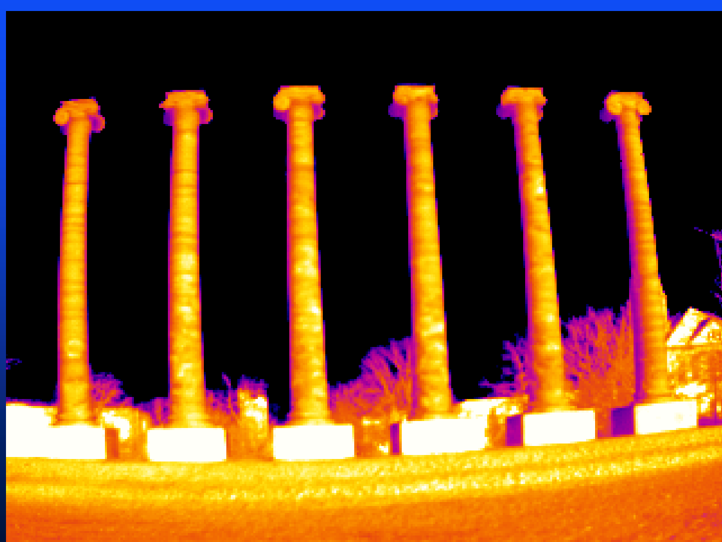
- Fixed scour monitoring is being used on a wide variety of bridges and sites

- Custom-designed and site-specific -
  Bridge, channel, topography and risk

- Major challenges are in the implementation:
  - Maintenance and repairs
  - Developing and maintaining a response protocol and responsibilities

NCHRP 20-07(252)
Guideline for Implementing Quality Control and Quality Assurance for Bridge Inspection

Glenn A. Washer, Ph.D., P.E.
Assistant Professor
University of Missouri
Columbia, MO



Agenda

- Introduction
- Goals and Objectives
- QC Reviews
- QA Models
- Conclude

Introduction

- Revisions to the NBIS require systematic QC and QA to maintain a high degree of accuracy and consistency
- AASHTO/FHWA/NCHRP scan in 2007 “Bridge Evaluation Quality Assurance Scan”
  - Assist in NBIS regulation implementation
  - Explore effective bridge inspection systems in other countries
    - QC/QA procedures and methodologies
  - Review types of data collected by other countries
- Scanning tour found some innovative QA approaches, technical decision making process for inspection scope and schedule, .….

Introduction (cont.)

- In the US, implementation methods for meeting NBIS are diversified
  - Different organizational structures for State DOT's
    - State bridges, counties, cities, towns, townships, communities, etc.
    - Consultants, State Forces, local forces, etc.
  - Different levels and status of QC/QA implementation
    - Some States have existing, comprehensive systems
    - Some States have development needs
    - Some States would like to improve/validate their approach
- FHWA framework for QC/QA provided guidance and example State program data
  - Assistance / examples of how the framework is implemented within a bridge inspection program was needed
  - Assist States in identifying QC/QA practices suitable within their own program structures, resources and needs

Goals and Objectives

- Goal: To improve bridge safety be developing guidelines for implementing advanced QC/QA procedures
- Objective: Develop a guideline document that can be used by State DOT's for implementing QC/QA procedures within their bridge inspection programs
  - Document current practices in the US
  - Provide a guideline that allows owners to consider practices that best fit their programmatic needs

Approach

- Collect data on existing QC and QA programs and methods
  - Interview State DOT personnel
  - Review available literature and available documentation of State practices
  - FHWA data compiled by the office of bridge technologies on innovative practices
- Develop generic models of QA procedures, such that the overall model can be easily adjusted to meet programmatic needs
- Document current QC and QA procedures

Quality Control (QC) and Quality Assurance (QA)

- *QC: Procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level (NBIS)*
- *QA: The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program (NBIS)*
- What is Quality?

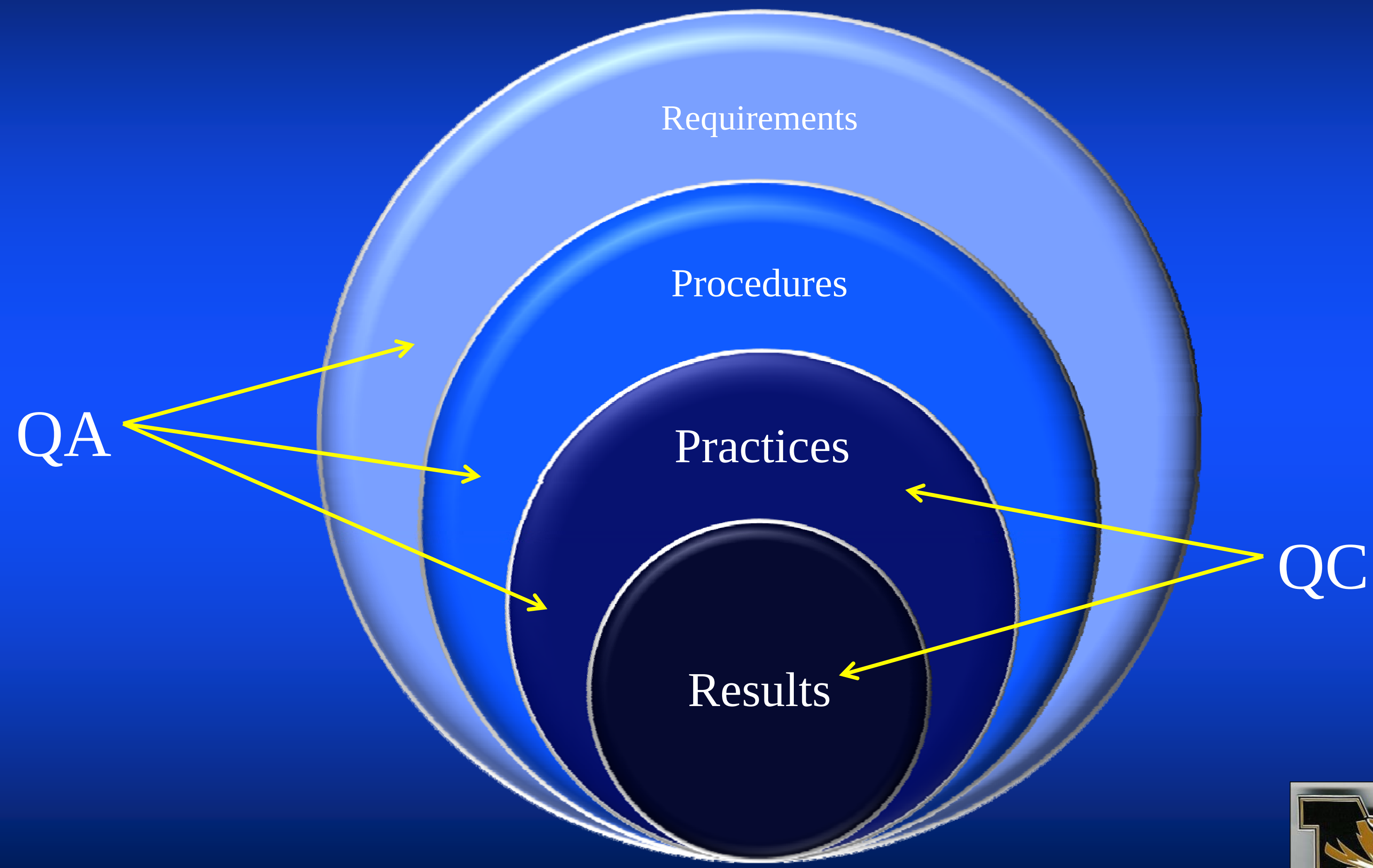
Quality

- "Quality" is inversely proportional to variability
  - *The good quality of an entity means that its quality dimensions have little or no variation from target values*
  - For Bridge inspection, this means that procedures meet requirements, practices correctly implement procedures, and the inspection results meet target values.
    - Vertical clearance, condition rating (1-9), scheduling of inspections, scour action plans, etc.

QC vs. QA

- QC is done within a work group to ensure the adequacy of *specific bridge inspection reports*
  - Sometimes delegated to consultants, local bridge owners, district/regional office
- QA: Conducted from outside the work group to evaluate:
  - Effectiveness of QC
  - Consistency of inspection results
  - Corrective actions for requirements and procedures
    - Inspection requirements
    - Rating manuals
    - Training needs
    - Annual bridge inspector meetings

QC vs. QA



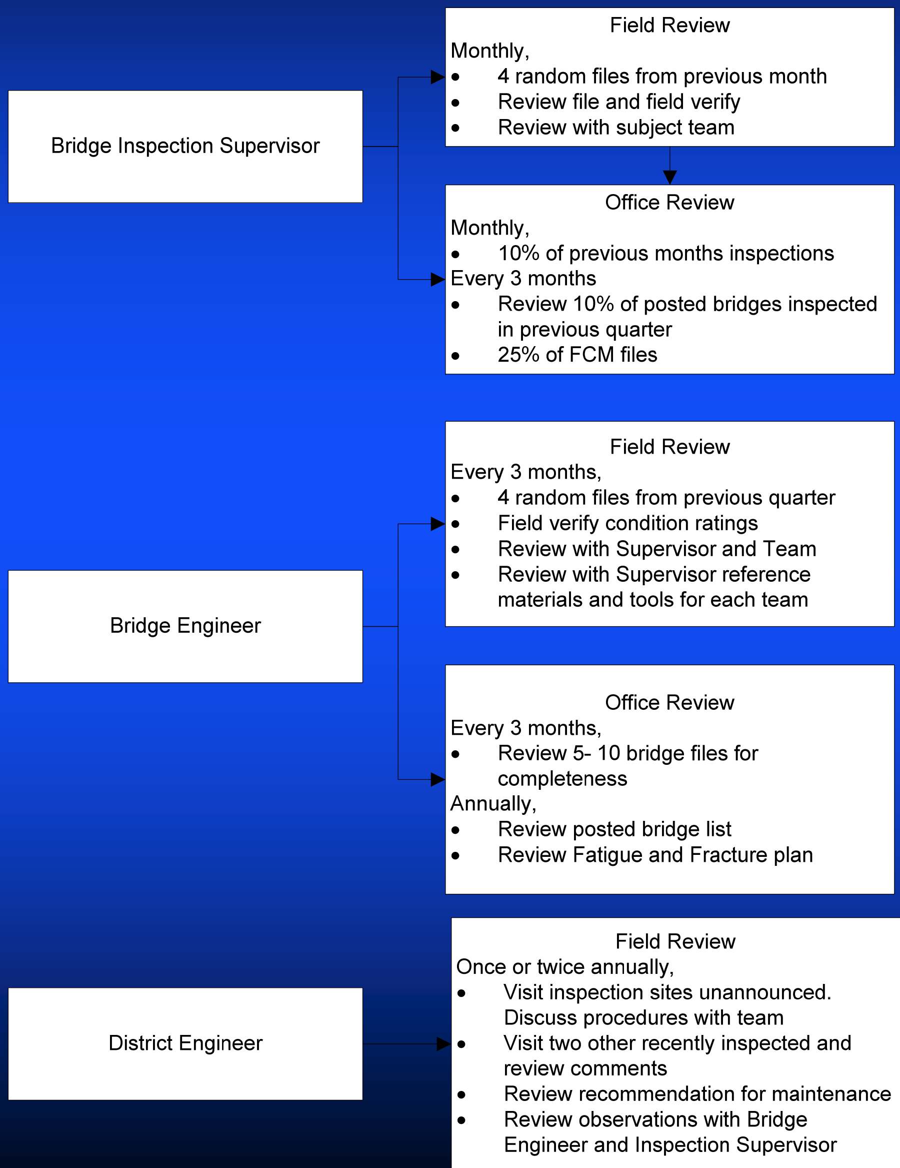
Dimensions of Quality

- A "quality dimension" is a characteristic that provides a measure of quality. For example, conformance of an inspection to established procedures is *dimension* of quality
  - Consistency of NBI ratings
    - Adequacy of notes/photos/sketches
  - Accurate CoRE selection
    - Condition state allocation
  - Critical findings
    - Identification and resolution
  - Inventory items
    - Clearance, waterway profile, width, length, location, etc.
  - Inspection scheduling
  - Underwater inspections, scour POA
  - Many others…..

Quality Control Review Procedures

- QC Office review
  - Review reports for consistency, procedure, documentation (photos and sketches)
- QC Field Review
  - Confirm inspection results by visiting bridge site ; check accuracy of ratings, inventory items, documentation (photos, sketches and notes)
- QC Field Performance Review
  - Review the performance of inspection team in the field by observing inspection practice
- Typically conducted by a QC personnel with
  - Independence from original inspection
  - Full and operational knowledge of inspection program requirements, procedures and intended practices.

Hierarchical QC Structure



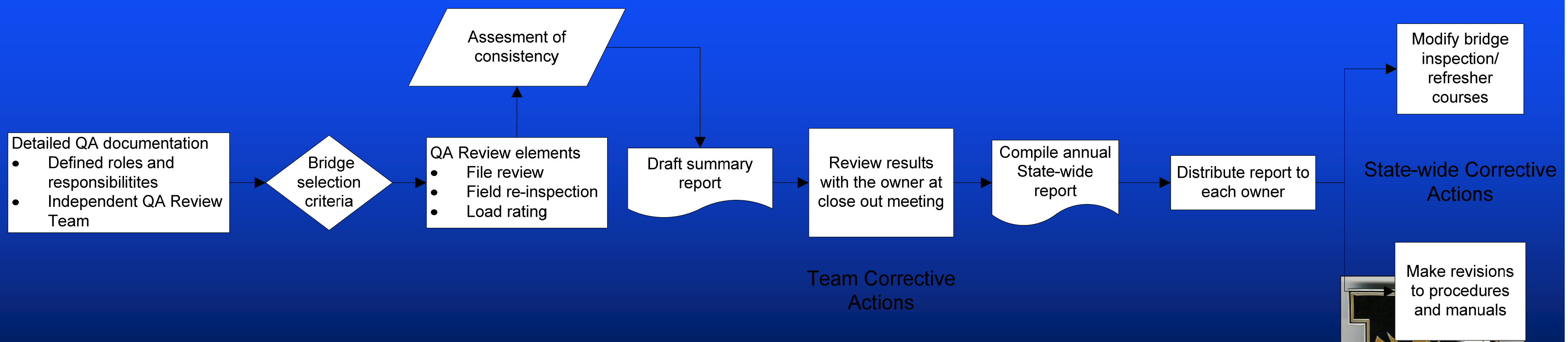
- Advantages:
  - Redundant QC procedures
  - Review of the reviewer
  - Management features and oversight
- Disadvantages
  - Costly, time consuming

QA Models in the US

- Independent Oversight Model
  - Re-inspection of bridges by a 3rd party
- Control Bridge Model
  - All inspectors inspect the same 2-3 bridges
  - Compare with expert team (control inspection)
- Collaborative Peer Review Model
  - Peer team and inspectors re-inspect bridges
- Field Verification Model
  - Field check of inspection results by program manager (or other supervisor)

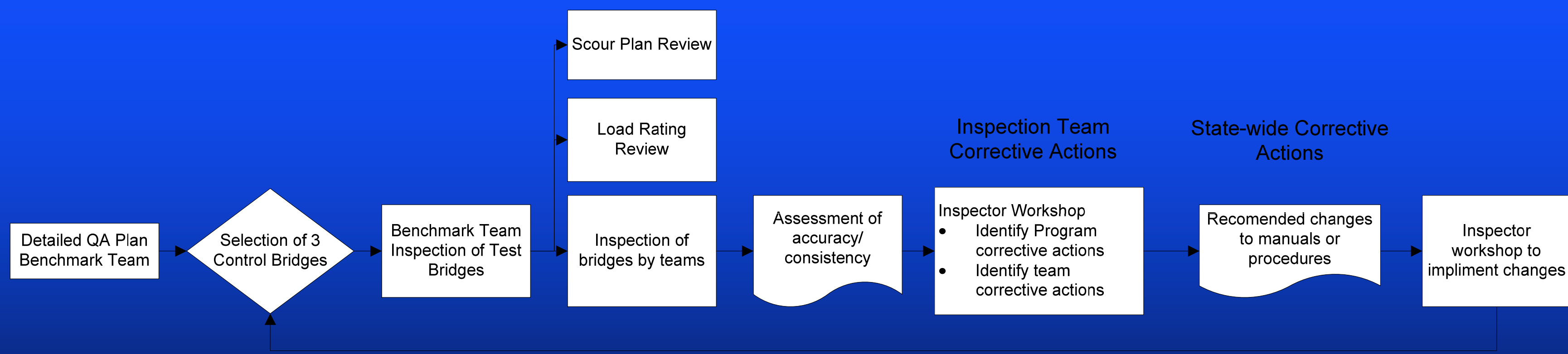
Independent Oversight Model

- Independent 3rd party conducts a independent re-inspection of sampling of bridges
- Document variations between re-inspection and original inspection result
- Corrective actions for teams through team-specific report; system-wide report developed from integrating data from individual reviews



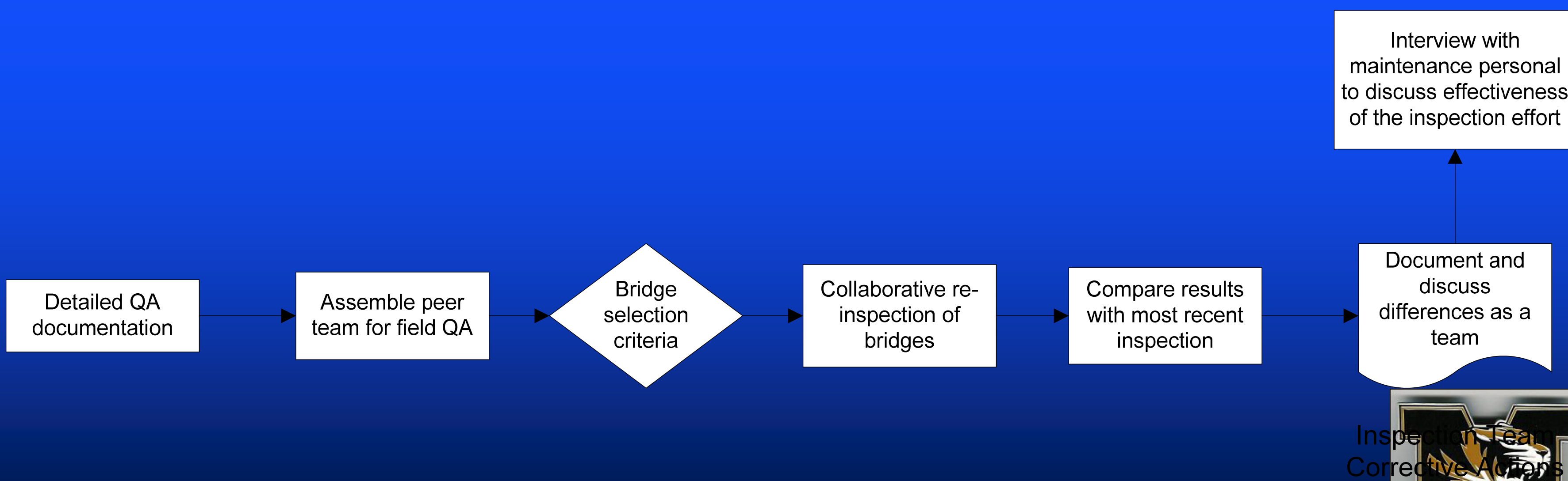
Control Bridge Model

- 2-3 bridges selected as “Control Bridges”
  - Inspection conducted by “expert team” to provide a “control inspection”
- Inspectors (from across the State) conduct independent inspection of the same bridges
- Compare with control inspection; discuss in annual inspectors meeting, identify corrective actions
- “Calibration,” apples to apples comparison, inspector buy-in



Collaborative Peer Review Model

- Collaborative , independent re-inspection of bridges with peer team assembled from other districts, central office, design, etc.
- Discussion of ratings/condition states, element selection, etc during the collaborative inspection
- Compare results of collaborative inspection with original inspection results
- Discuss differences and resolve issues
- Collect data from CPR reviews for system/programmatic analysis



Comments and Conclusion

- Documentation is a critical element in the quality process
  - Who does what, when, how, where, etc….
  - Allows for understanding of the program, oversight and review, and promotes good communication
- Positive environment for review
  - The goal of QC/QA is to ensure high-quality results, everyone wants that…
  - The goal is not to identify deficient personnel, teams or districts
    - This may be an outcome, but not the focus
    - Positive environment of communication and teamwork will yield more effective results, help raise quality across the program

MISSOURI

NCHRP 20-07 (252) Status

- Draft final report submitted to NCHRP
  - Report describes current practices for QC/QA
  - Motivations and approaches
  - Allow owners to consider different methodologies that best fit their programmatic needs
- Comments from panel currently being addressed

Questions?

washerg@missouri.edu

Tonight 9:37 pm EST