Improved Regionalization of Quality Assurance (QA) Functions (a.k.a. Sharing Inspection Resources)

Eshan Dave, Michael Kotowski, Rasool Nemati
Jo Sias Daniel, Ricardo Medina, Alan Perkins

17 October 2017

Department of Civil and Environmental Engineering
University of New Hampshire

University of New Hampshire

Outline

- Study Motivation and Objectives
- Review of New England QA processes for PSE/PCE
- Proposed Regionalized QA Process
- Logistics for Regionalization

Background of QA Procedures for PCE/PSE

- CFR Title 23 Part 637
  - QA processes ensure that desired level of quality is maintained throughout the manufacturing and construction processes
- AASHTO R38 gives the minimum requirements
- Significant cost savings can be realized if regionally accepted procedures are developed:
  - Inspection and testing resources can be shared
  - Streamlines producer operations when supplying to multiple agencies
- Differences exist between QA procedures of various agencies

1. List of Fabricators Currently (recently) Supplying PSE/PCE to NE DOTs

- **PCI Certified Suppliers**

State	No. of PCI Cert. Fabricators
CT	3
MA	6
ME	1
NH	1
RI	5
VT	3

1. List of Fabricators Currently (recently) Supplying PSE/PCE to NE DOTs

- **NPCA Certified Suppliers**

State	No. of NPCA Cert. Fabricators
CT	3
MA	6
ME	1
NH	3
RI	1
VT	3

Study Scope and Objectives

- Review of current QA process used by New England DOTs for PCE/PSE
  - Literature review
  - QA Specifications
  - Interviews
- Propose regionalized QA process for PCE/PSE to be used by NETC constituents
- Explore cost-sharing mechanism to accompany the common acceptance standards

Review Methodology

- Information Gathering
  - Preliminary specification review
  - Questionnaire
  - Interviews with constituents
    - *Detailed specification and QA process review*
  - Fabricator visits (Oldcastle, J.P. Carrara)
    - *QA process*
    - *Feedback*

Review Methodology

- Information Processing
  - Master table of the QA process activities
    - *Able to develop similarities and differences amongst the agencies.*
  - Information was sorted and aspects of QA process were identified that would be most impacted by regionalization
    - *Comparisons were made on these aspects and recommendations are generated*

Review of State Practices

- Brief summary is presented here:

1. Qualification and Certification of Plant/Fabricator
2. Fabricator QC Requirements
3. QA Process (Agency Inspection)
4. Curing Requirements
5. Miscellaneous

1. Qualification and Certification of Plant/Fabricator

- Pre-stress (PSE) Fabricators

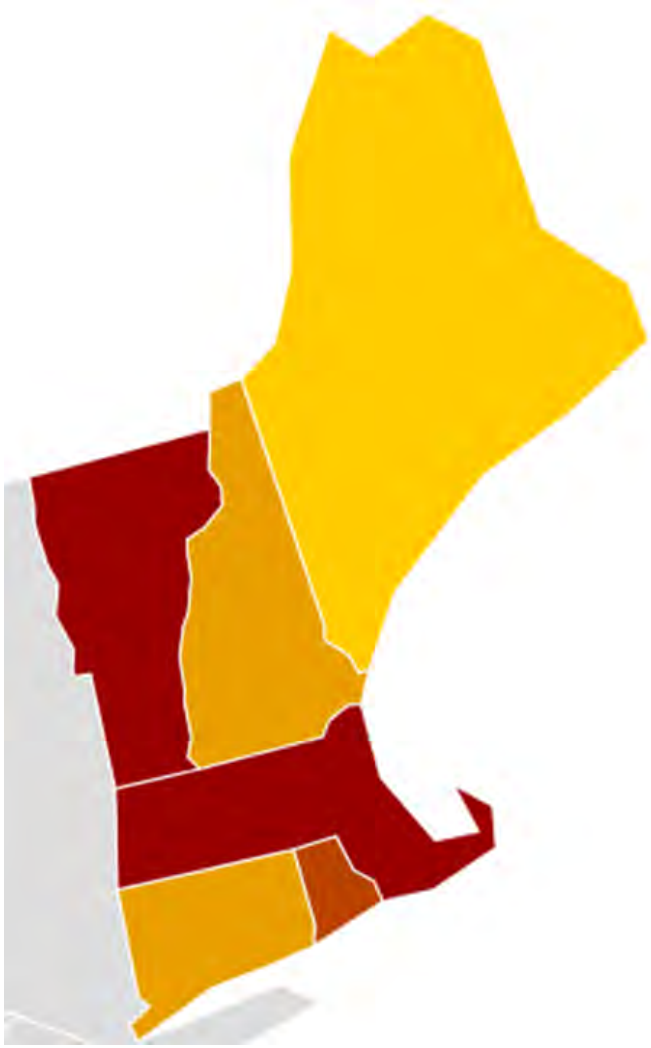
PCI

PCI + Agency Audit

Agency Prequalification

1. Qualification and Certification of Plant/Fabricator

- Non pre-stress (PCE)



PCI

PCI/NPCA + Agency Audit

Agency Audit

None

1. Qualification and Certification of Plant/Fabricator: Inspector Office

- Inspector Office/Facilities Requirements
  - RIDOT have the most comprehensive specification detailing the office requirements
  - Other agencies have similar requirements

2. Fabricator QC Requirements

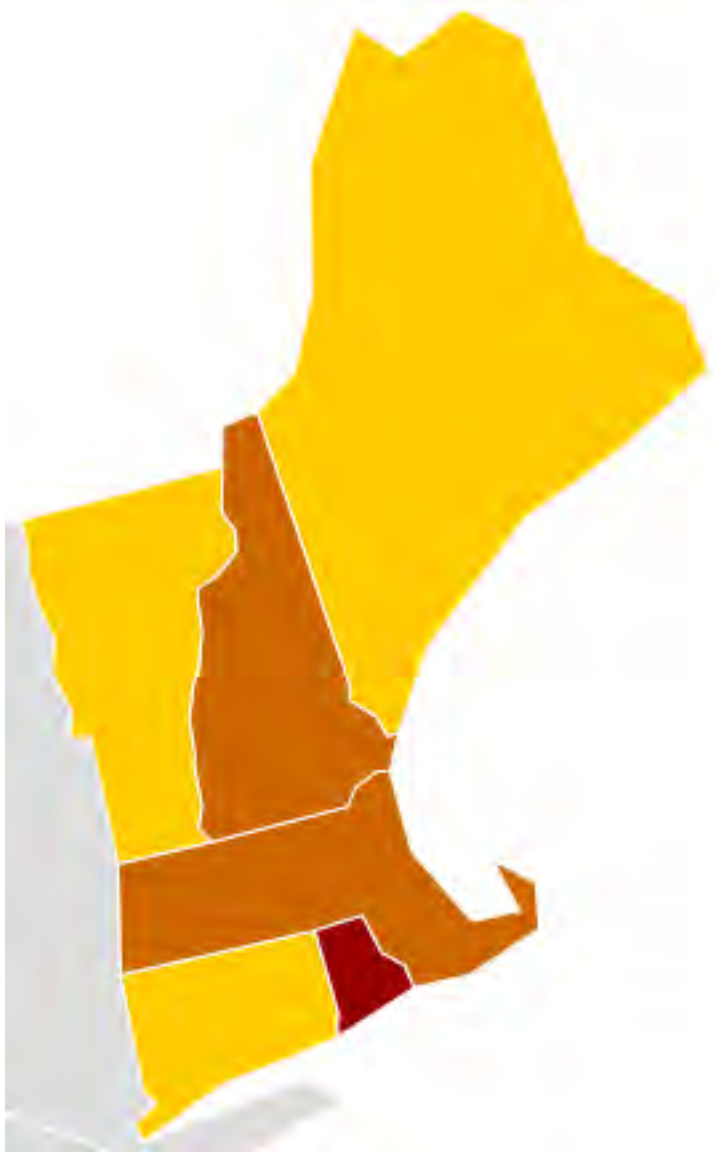
- Quality Control Manual/Quality Service Manual
  - PSE
    - *PCI MNL-116 for all agencies*
  - PCE
    - *PCI MNL-116 (MA)*
    - *NPCA (MA, ME, NH, VT)*
    - *Agency specified requirements (RI)*

2. Fabricator QC Requirements

- Qualification of QC Technician
  - PSE
    - *PCI Level 2 (All States)*
  - PCE
    - *ACI Level 1 or 2 (MA, CT, ME)*
    - *PCI Level 2 (NH)*
    - *No requirement (RI, VT)*

3. QA Agency Inspection

- Employee versus Consultant Inspectors



Both

Consultants

Employees

3. QA Agency Inspection

- Inspector Qualification

Agency	Prestressed Inspector Qualification	Precast Inspector Qualification
CT	ACI level 1 equivalent	ACI level 1 equivalent
MA	PCI Level 2	-
ME	PCI Level 2	PCI Level 1, 2, or 3
NH	PCI Level 2	PCI Level 2
RI	In-House Certification	In-House Certification
VT	PCI Level 1	PCI Level 1

3. QA Process: Inspection

- Pre-Pour (PSE/PCE)
  - The processes showed strong similarities amongst the six states
    - *Comparison of the pre/post pour checklists provided by each agency.*

3. QA Process: Agency Testing

- Plastic Concrete Testing
  - Frequency of Plastic Concrete Tests
    - *CY, load, lot size, etc.*

Agency	Spread	Air Content	Temperature
CT	Witness QC Results		
MA	Once per pour		
ME	First two (2) loads, then at discretion of QAI on basis of consistency		
NH	Per sublot (typ. 1/item)		
RI	Once per 150 CY or each day's production		
VT	First load + whenever cylinders are cast		

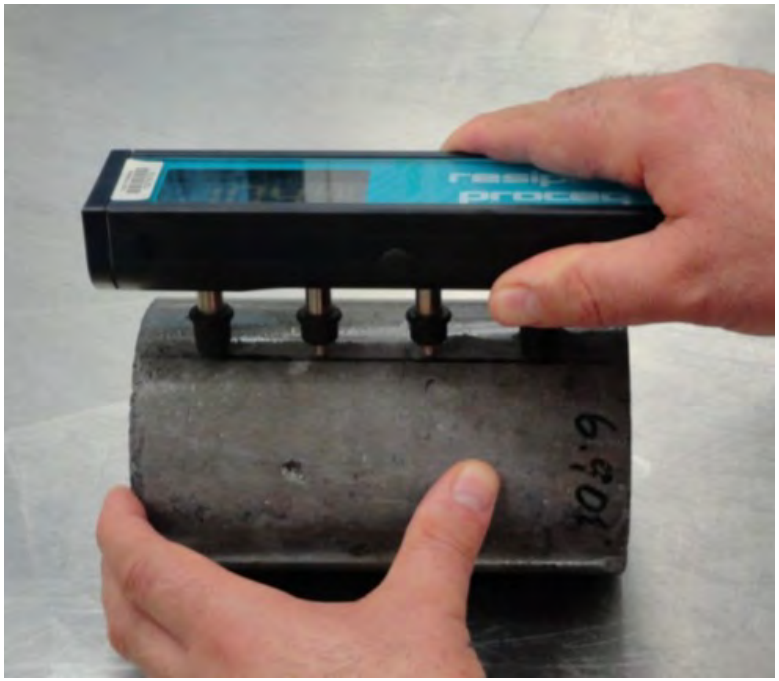
NHDOT also require w/c ratio testing using microwave method.

4. QA Process: Inspection

- Post-Pour (PSE/PCE)
  - The checklists provided by each state varied slightly
    - *Maine DOT has the most comprehensive post-pour checklist*
  - Watching the element get loaded on transport requirement varies

4. QA Process

- Additional Hardened Concrete Testing
  - Maine and New Hampshire DOT – Permeability testing using AASHTO T-358, “Surface Resistivity Indication of Concrete’s Ability to Resist Chloride Ion Penetration.”



4. Curing Requirements

- Ranged from well-prescribed requirements to not being included in the QA process.

Agency	Curing Requirements
CT	Not Inspected – Follow MNL-116
MA	*Procedures Under Development*
ME	MNL-116 with exceptions. • Temperature gain <40˚F/hr. • Initial set determined by ASTM C403 • Maximum temperature of 160˚F • Minimum temperature of 120˚F • Until 80% of design strength is achieved
NH	Item Specific
RI	Accelerated curing allowed for PSE
VT	-

5. Miscellaneous

- Fairly consistent requirements for IA
  - Inspectors are typically IA'ed once per year

- Estimated Inspection Cost
  - The agencies provided an hourly rate estimate for consultant inspectors.
  - It was found that the hourly rate ranged from $50/hour to $100/hour.
    - *The lower end of the spectrum does not include travel reimbursement while the higher range incorporates additional costs for travel.*

QA Process Review Summary

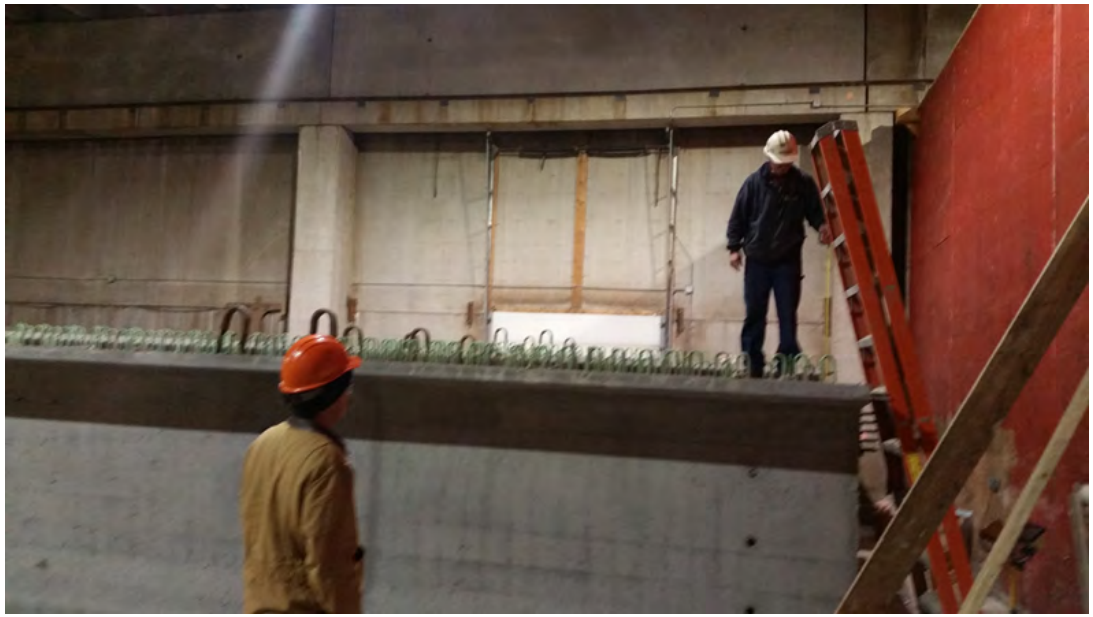
- Attributes that are most dissimilar between agencies:
  - Sampling frequencies
  - Inspector qualification
- Prestressed concrete element QA processes are more similar between agencies
- Preliminary recommendations are made for regionalized QA process

QA Cost Share Mechanisms

- At present no formal mechanism exists between other States DOTs
- Several DOTs conduct tests for other agencies, standard testing rates are established and costs are typically charged to the project
- Main challenge is costs associated with inspection and on-site testing

Regionalized QA Process Recommendations

1. Three Categories: PSE, Structural PCE, Non-Structural PCE
2. Plant Certification and Producer Testing Requirements
3. Agency Inspection
4. Logistics



1. Recommendation Layout (Categories)

- Prestressed Elements (PSE)
  - Examples:
    - *NHDOT Item 528, RIDOT Item 809, MEDOT Item 535*
- Structural Precast Elements (precast piles, precast concrete superstructure etc.)
  - Examples:
    - *NHDOT Item 594, RIDOT Item 804, MEDOT Item 534*
- Non-structural Precast Elements (catch basins, storm drains etc.)
  - Examples
    - *NHDOT Item 603, RIDOT Item 702, MEDOT Item 603*

2. Plant Certification

Item	Element	PCI/NPCA Requirement	Additional Recommendations
QC Plan (QSM) and Plant Requirements	PSE	PCI MNL-116	PCI MNL-137 for repair works and AASHTO M-157 for Ready Mix
	Structural PCE	PCI MNL-116/NPCA	
	Non-Structural PCE	NPCA	

PCI CERTIFIED PLANT

NPCA CERTIFIED PLANT

AASHTO THE VOICE OF TRANSPORTATION

2. Producer Testing Recommendations (modifications to NPCA/PCI)

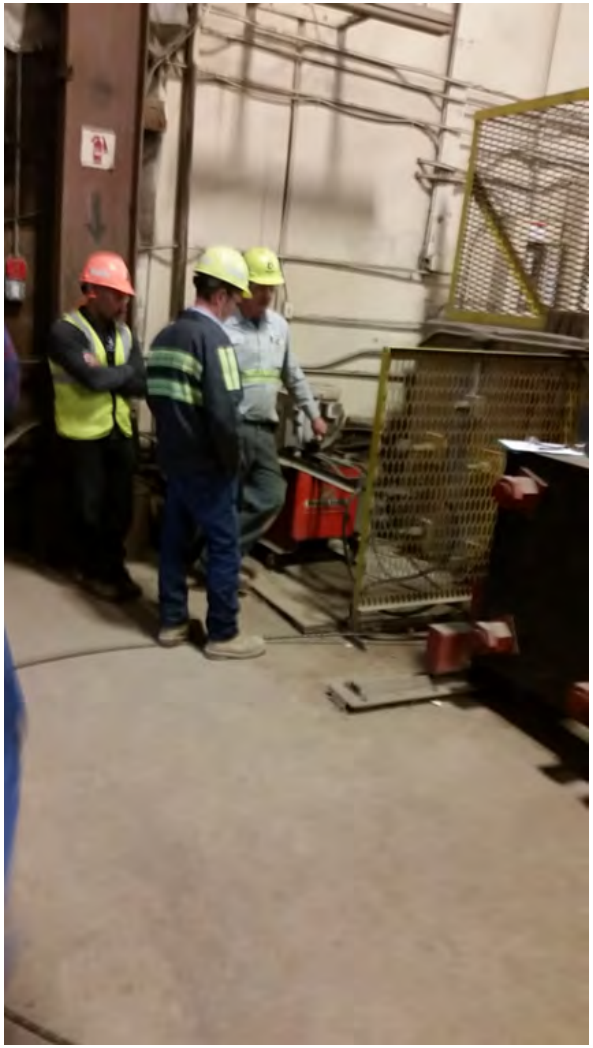
Item		Element	PCI/NPCA Requirement	Additional Recommendations
Sampling and Testing	Casting Bed	PSE	-	Profile and Alignment check
		Structural PCE	-	
		Non-Structural PCE	-	
	J-Ring or L-Box (AASHTO T-345 or ASTM C 1611)	PSE	-	For each SCC design and at the start of each element type
		Structural PCE	-	
		Non-Structural PCE	-	-
	Strength Cylinders	PSE	Minimum of 4 Cylinders per element	Additional 4 cylinders for de-stressing strength
		Structural PCE	4 Cylinders; PCI: Daily for each individual concrete mix, or every 75 CY NPCA: Every 150 CY per mix or once per week	Min. once per each day's production or every 150 CY
		Non-Structural PCE	4 Cylinders, every 150 CY per mix or once per week	Min. once per each day's production or every 150 CY

2. Fabricator QC Technician Requirements

- PSE
  - Minimum of PCI level 2 or higher qualification (or new NETTCP PS level 1 certification)
- PCE
  - Minimum of ACI level 2 or PCI level 1 (or NETTCP PS level 1 certification)
  - ACI level 1 is also acceptable for non-structural PCE

3. Agency Inspection: Pre Pour

- Minimal differences between agency practices.
- Maine and New Hampshire check-lists are the most comprehensive and user-friendly
- A combined version of these is proposed to be used



3. Agency Testing Recommendations

Inspection Criteria		Element	Test Frequency
During Pour	Temperature	PSE	At least once per element and every 100 CY
		Structural PCE	
		Non-Structural PCE	Once per continuous pour
	Water/ Cementitious	PSE	At least once per element and every 100 CY
		Structural PCE	
		Non-Structural PCE	Once per continuous pour
	Strength Cylinders	PSE	Once per element or every 100 CY; Number: Total 6 cylinders for permeability and strength testing
		Structural PCE	
		Non-Structural PCE	Once per continuous pour; Number: Total 4 cylinders for strength testing

3. Agency Inspector Qualification

- PSE
  - Minimum of PCI level 2 or higher qualification (or NETTCP PS level 1 certification)
- PCE
  - Minimum of ACI level 2 or PCI level 1 (or NETTCP PS level 1 certification)
  - ACI level 1 is also acceptable for non-structural PCE

5. Curing Requirements

- Accelerated curing is the current state of the practice
- PSE and Structural PCE:
  - Controlling temperatures shall be those actually achieved within the concrete elements
  - Accelerated curing should started after concrete has attained initial set
  - Concrete temperature may be increased during the preset period at a rate of 10˚F per hour or less
  - Total temperature gain during the preset period should be less than 40˚F higher than the placement temperature or 104˚F (lower of two)
  - A heat gain should not exceed 36˚F per hour, measured in the concrete, provided the concrete has attained initial set

6. Logistics of Regionalized QA Process

- Need central entity to manage QAI pool
  - Central managing entity might be the solution (NETC or NETTCP like model)
  - ShiftPlanning or similar system (currently used by Vtrans) could be used to manage the pool and for purposes of scheduling
- Initial trials could be conducted using only consultant inspectors
  - Current range of rates are established and can be used for planning purposes
  - Focus initial trials for pre-stressed elements (simpler to unify QA process requirements)
- Technology could really help streamline the process
  - RFID tags + cloud-based storage
    - *Currently being explored by various agencies*
    - *Could serve as vehicle for real time data transfer*

Thank you for your attention

Contact:
eshan.dave@unh.edu
Phone: 603-862-5268