Quality Assurance Concepts

Peter C. Taylor

Outline

• What is quality?
• Who cares?
• How do we get it?
• What is the important stuff?
Defining Quality

- Simple Definition (Philip Crosby)
  - Quality: “Conformance to requirements”
  - Quality is defined by our customers

- QA = “Making sure the quality of a product is what it should be”

Core Elements of a QA Program

- Quality Assurance
- Quality Control
- Agency Acceptance
The Goal...

Long-lasting pavement

Acceptance

QC TOOLS!

Construction Activities

Outline

• What is quality?
• **Who cares?**
• How do we get it?
• What is the important stuff?
Why Should I Care

**CONTRACTOR**

- Money!
  - Penalties vs Incentives

**OWNER**

- Better working environment
- Project partners are qualified
- Contractor knows how the Agency will accept/pay for the product
- QC Plans remove some of the daily stress
- Product you paid for
Outline

• What is quality?
• Who cares?
• How do we get it?
• What is the important stuff?

Trick Question

• How do the following people affect quality?
  • Designer/Specifier
  • Agency Inspector
  • QC Technician
  • Loader Operator at the concrete plant
  • Truck Driver
  • Paver Operator
  • Concrete Finisher
  • Texture/Cure Machine Operator
Problems Occur When QA Items Are Considered Separately
Core Elements of a QA Program

Quality Assurance
Quality Control
Agency Acceptance

Quality Control

• Contractor’s QC system should address:
  • Materials production processes
  • Materials transportation and handling
  • Field placement procedures
  • Calibration and maintenance of equipment
  • Watching the process
  • Fixing the process
Acceptance

- Agency must carry out all acceptance activities
- Agency must independently inspect and test for Acceptance
- Contractor QC data may be used in Agency Acceptance

Core Elements of a QA Program

- Independent Assurance
- Dispute Resolution
- Qualified Labs
- Qualified Personnel
Independent Assurance

- Provides an assessment of personnel proficiency and equipment
- Provides independent check on reliability of results of both partners
- Not used to make a determination of quality/acceptability of the product

Dispute Resolution

- Formal system designed to address significant differences between partners data of such magnitude to impact payment
- Not intended to address day to day issues
- Required (by FHWA) when QC results used in Acceptance decision
Qualified Laboratories & Accredited Laboratories

- AASHTO Accredited
  - All State Central Labs
  - Any lab conducting Dispute or IA testing
- All other labs must be qualified through a state sponsored program.

Quality Measurement Tools

- Two principal tools used to measure conformance with requirements:
  - Inspection
  - Testing
Inspection

- Equipment
- Environmental Conditions
- Materials
- Product Workmanship

Testing

- Three criteria:
  - Quality Characteristics (What do we need?)
  - Quality Measures (How do I measure it?)
  - Quality Limits (How much is enough?)
QA Principles

• N = 1

• 3 Sources of Variability
  - Tester
  - Equipment
  - Procedures

QA Principles

• Types of Tests
  • Random Samples
    - For compliance with specifications
    - No others count for compliance
  • Process control Test
    - Not Random
    - Contractors use when needed
      - Change in process or material
  • Independent Assurance
    - Not the project personnel
Outline

- What is quality?
- Who cares?
- How do we get it?
- What is the important stuff?
What is Important?

1. Design
2. Support system
3. Mixture
4. Construction

Design

- Joints
- Thickness
- Strength
Jointing & Load Transfer

- Joints are cut to prevent random cracking
  - Details can influence cracking risk
    - Base friction
    - Panel dimensions
    - Curling and warping

<table>
<thead>
<tr>
<th>Loading position *</th>
<th>Maximum subgrade pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>psi</td>
</tr>
<tr>
<td>1. Slab interior</td>
<td>3</td>
</tr>
<tr>
<td>2. Transverse joint edge</td>
<td>4</td>
</tr>
<tr>
<td>3. Outside edge</td>
<td>6</td>
</tr>
<tr>
<td>4. Outside corner</td>
<td>7</td>
</tr>
</tbody>
</table>

* 12,000 lb. Load on a 12-in plate (~100 psi)
Joints

- Pay attention to
  - Locations
  - Type
  - Timing
  - Load Transfer
  - Details

Jointing & Load Transfer

- Typical problems...

Late Sawing  Bad shoe on early entry saw  Poor detailing
Support System

- Support should be
  - Uniform
  - Strong enough
  - Stiff enough
  - Stable

Foundation Stiffness
Manage Foundation Movement

Causes of subgrade movement:
- Non-uniform soils
- Fines / Permeability
- Moisture Content
- Low Strength
- Poor Consolidation
- Settlement
- Frost susceptible soils

Mixture

- Strength
- Permeability
- Frost resistance
- Shrinkage
- Controlled by
  - w/cm
  - SCM type and dose
  - Air void system
  - Consolidation
  - Curing
Mixture Design

- Process of determining required and specifiable characteristics of a concrete mixture:
  - i.e. Choosing what you need

Mixture Proportioning

- Process of determining the quantities of concrete ingredient
  - i.e. choosing what to use to get what you need
Construction

• Materials
• Batching
• Placing
• Sawing
• Caring and Keeping

Good Practice

• Watch materials uniformity
• Beware of “incompatibility”
• Allow for changes in weather
Don’t Add Excess Water

Adding 1 gal. of water to 1 yd$^3$ of concrete:

- Increases slump 1 in.
- Decreases compressive strength by 200 psi
- Wastes the effect of 1/4 sack of cement
- Increases shrinkage by 10%
- Increases permeability by up to 50%
- Increases risk of air void problems

But We Never Add Water...
**Construction**

- Segregation
  - Use the right tools
- Consolidation
  - Not too much, not too little (~8000 vpm)

**Curing**

- Start early vote often
- Keep it wet and warm
- 7 Days would be nice
- Does it affect strength?
**Thermal Protection**

- Avoid thermal shock
- Protection from cold fronts

**Jointing & Sawing**

- Concrete expands as temperature rises and as moisture falls
Sawing

• Be like Goldilocks
  ➢ Not too early
  ➢ Not too late

Factors that influence life and smoothness

• Foundations
  • Stiffness
  • Stability
  • Uniformity

• Concrete
  – Thickness
  – Surface
  – Load transfer
  – Uniformity
  – Workability
  – Strength
  – Durability