

# Quality Assurance Concepts

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IOWA STATE UNIVERSITY  
Institute for Transportation

## Outline

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



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## 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”



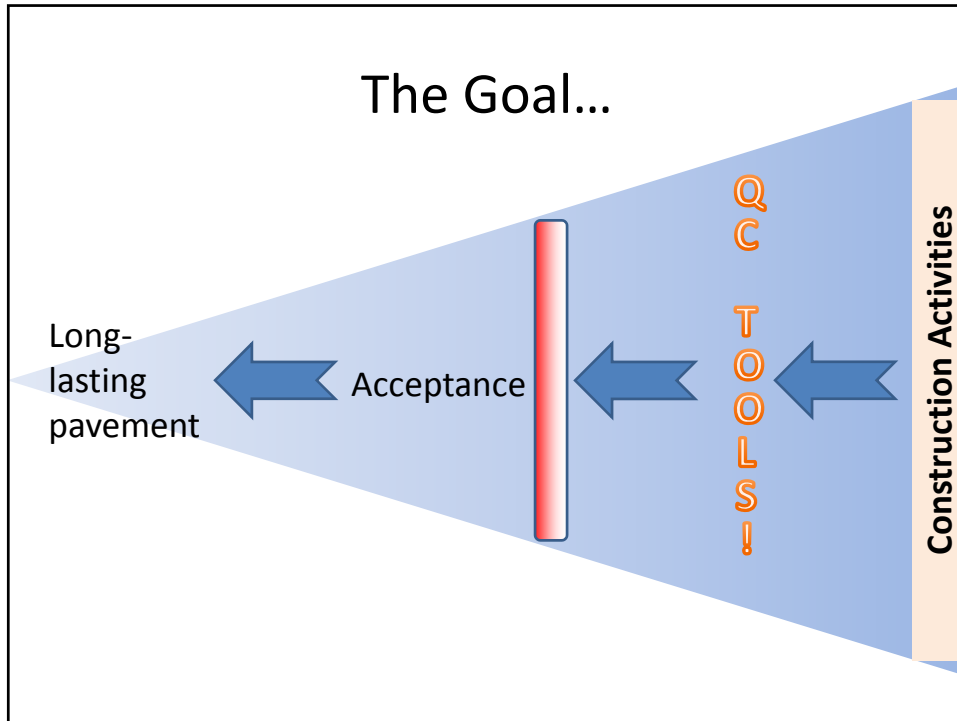
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## Core Elements of a QA Program



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## Outline

- What is quality?
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- How do we get it?
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CP  
Tech Center

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## Why Should I Care

- Money!
  - Penalties vs Incentives



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CONTRACTOR

## Why Should I Care

- 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



OWNER

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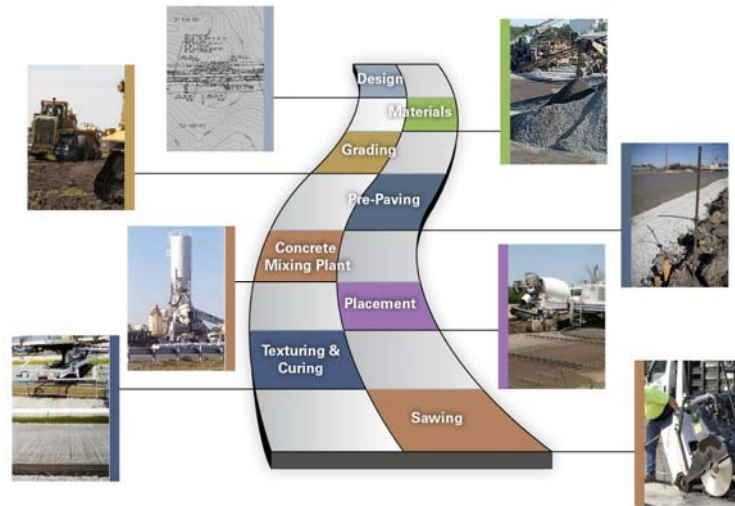
## Trick Question

- 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



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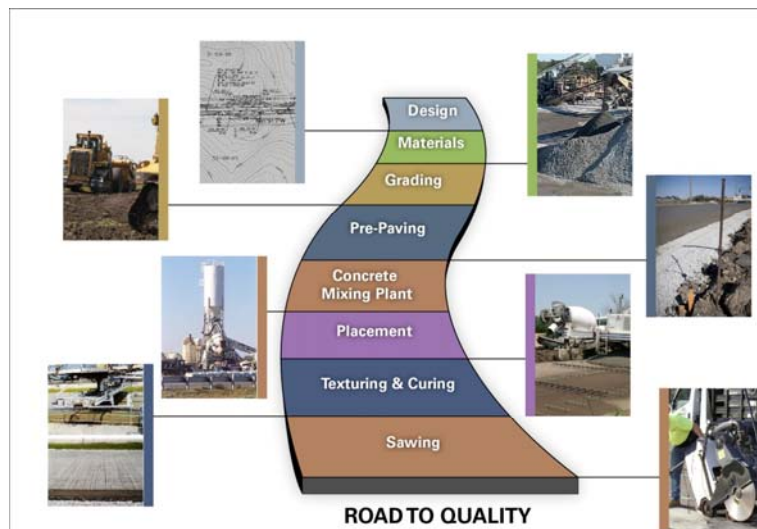
# Problems Occur When QA Items Are Considered Separately



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**QUALITY CHALLENGE**  
FOR LONG LIFE CONCRETE PAVEMENT



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**ROAD TO QUALITY**

**QUALITY CHALLENGE**  
FOR LONG LIFE CONCRETE PAVEMENT

## Core Elements of a QA Program



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## 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



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## 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



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## Core Elements of a QA Program

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



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## 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



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## 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



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## 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.



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## Quality Measurement Tools

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



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## Inspection

- Equipment
- Environmental Conditions
- Materials
- Product Workmanship



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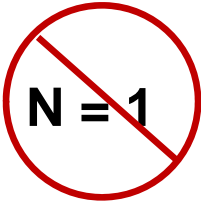
## Testing

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



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## QA Principles

-  **N = 1**
- 3 Sources of Variability
  - Tester
  - Equipment
  - Procedures



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## QA Principles

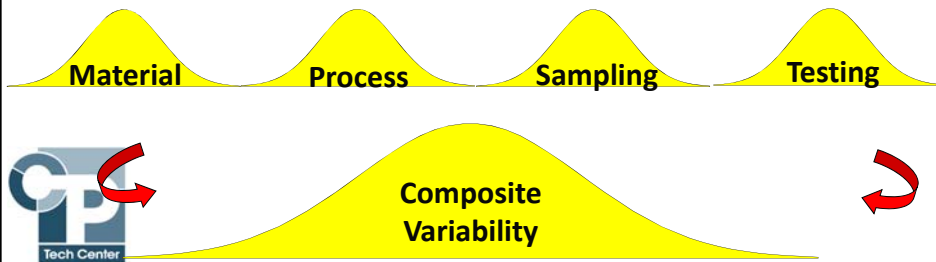
- Types of Tests
  - Random Samples
    - For compliance with specifications
    - No others count for compliance
  - Process control Test
    - Not Random
    - Contractors use when needed
      - Change in process or material
  - Independent Assurance
    - Not the project personnel



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## Sources of Variability

*Material*    *Process*    *Sampling*    *Testing*



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## Outline

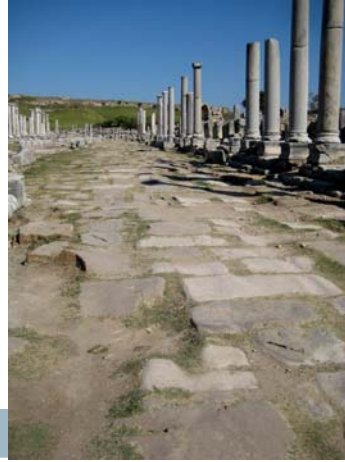
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## What is Important?

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



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## Design

- Joints
- Thickness
- Strength



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## Jointing & Load Transfer

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

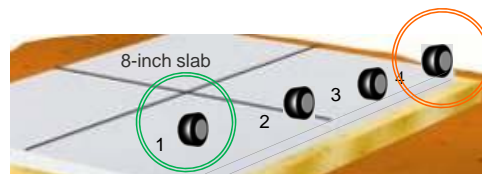


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## Jointing & Load Transfer

Loading position *	Maximum subgrade pressure	
	psi	tons per square foot.
1. Slab interior	3	0.22
2. Transverse joint edge	4	0.28
3. Outside edge	6	0.43
4. Outside corner	7	0.50

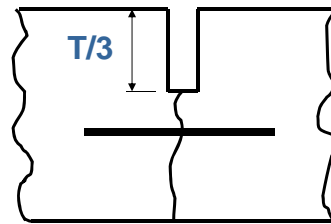
\* 12,000 lb. Load on a 12-in plate (~100 psi)



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## Joints

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



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## Jointing & Load Transfer

- Typical problems...



Late Sawing



Bad shoe on early  
entry saw



Poor detailing



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## Support System

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



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## Foundation Stiffness

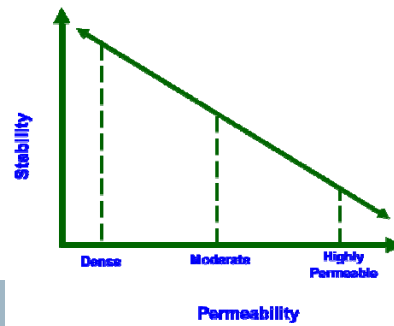


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# Manage Foundation Movement

## Causes of subgrade movement:

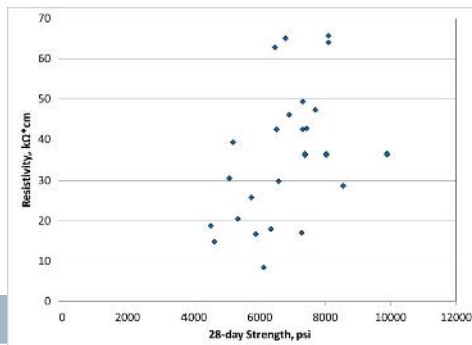
- Non-uniform soils
- Fines / Permeability
- Moisture Content
- Low Strength
- Poor Consolidation
- Settlement
- Frost susceptible soils



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# Mixture

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



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## 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



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## Construction

- Materials
- Batching
- Placing
- Sawing
- Caring and Keeping



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## Good Practice

- Watch materials uniformity
- Beware of “incompatibility”
- Allow for changes in weather



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## Don't Add Excess Water

Adding 1 gal. of water to 1 yd<sup>3</sup> 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



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## But We Never Add Water...



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## Construction

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

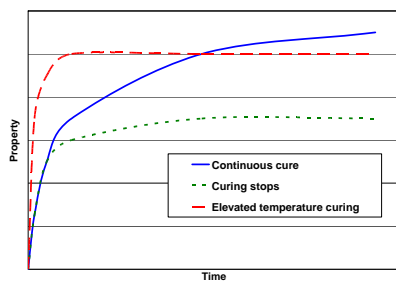


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## Curing

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



## Thermal Protection

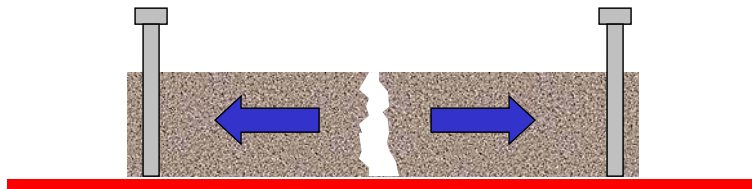
- Avoid thermal shock
  - Protection from cold fronts



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Construction

## Jointing & Sawing

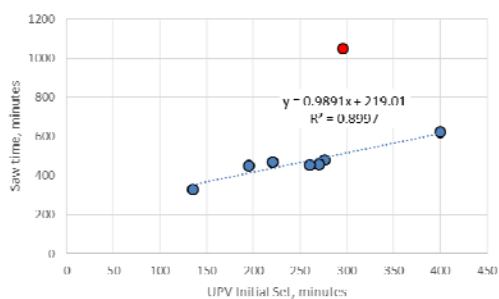
- Concrete expands as temperature rises and as moisture falls



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## 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