Performance Engineered Mixtures

National Concrete Pavement Technology Center



IOWA STATE UNIVERSITY

Institute for Transportation

Performance Engineered Mixtures

- How do we get what we need?
 ▶Later
- How do we know we got it?
 Pooled fund?
- How does the agency specify it?
 FHWA Implementation funds

How does the agency specify it?

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The Agenda

- What controls longevity?
- How do we measure them?
- How do we specify them?
- What do we do next?
- Aim to move the needle today
- Focus on materials
- Allow adoption of more sustainable materials

The Agenda

Point of View

Performance Specificati for Concr

BY PETER TAYLOR

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also be conside

Both of these

(and the public)

structure for its h

in its purest form

PRESCRIPTI

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The topic of parlormance-based specifications for concrete is training considerable decasation in the concrete construction industry. Current construction specifications are predominantly prescriptive with some performance aspects. Most agree that the balance between prescriptive and performance-based specifications needs to be changed to improve the probability of new construction addiving the desired service like at reasonable cost and with minimal disputes. This article presents a hybrid approach to altering current specifications that is locatible for implementation in foday's construction environment.

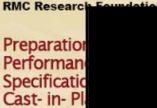
PERFORMANCE-EASED SPECIFICATIONS A pure performancebased specification would rad very simply: "The concrete structure must provide N years of service in the environment in which it is placed with a maximum of X amount of maintenance and repars." This approach would have the following effects: Primary risk would be placed onto the contractor and suppliers; and

This point of view article is presented for reader interest by the editors. However, the opinions expressed are not necessarily those of the American Concrete Institute. Reader communi is invited.



detail of the proje of materials, mixt to complete and r would have the in Primary risk wo Specifications v address every p Ensuring full co amount of sup Again, the cost would be high, an

HVBRID SPEC Current specifi performance and



Cast- in- I Concrete

Prepared by:

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A Synthesis of Knowledge of Potential Durability of Concrete

Long-Life Concrete: How Long Will My Concrete Last?

Peter C. Taylor, PhD October 2013

Reported by A

Report on Pe

Requirem



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Because even the best car





The process...

- Structural Design
- Mixture Design
- Mixture Verification
- Acceptance

Structural Design Based On

- Strength
- Modulus
- CTE
- Region
- Foundations
- Loading (traffic, trucks)
- Features (steel, shoulders, ...)
- Assumes durability
- So what about the mixture...

What controls longevity?

- Aggregate issues (ASR, d-cracking)
- Cold weather (freezing / salts / joints)
- Fatigue (strength / thickness / support)
- Cracking (moisture / thermal)
- Corrosion (permeability, protection)
- Bond (overlays)
- Abrasion / polishing (aggregates)

How do we control them?

- Aggregates Pre-qualify
- Cold AVS, permeability
- Strength w/cm, binder, consolidation, segregation
- Permeability w/cm, binder, uniformity, curing
- Cracking Shrinkage, temperatures, CTE. sawing
- Corrosion

Bond

CTE, sawing Permeability, binding Surface prep

How do we measure them?

• Aggregates AASHTO PP65, pore index Quarry inspection, **Tarantula** • Binders Calorimetry, indicators AVS SAM, AVA, foam drainage, foam index • w/cm Microwave, batch records, ray gun? Permeability Resistivity, RCPT, sorptivity, other?

How do we measure them?

- Uniformity
- Workability
- Segregation
- Strength
- Shrinkage
- Bond

- Slump, unit weight Slump, VKelly,
- on Dipstick
 - Cylinders, maturity Ring, C157, bFlat
 - Ring, C157, Di
 - C1583

When do we measure them?

- Aggregates Design / delivery
- Binders Delivery
- AVS Behind the paver
- w/cm At paver
- Permeability Design

QC QC AA AA AA

When do we measure them?

- Uniformity At pa
- Workability
- Strength
- Shrinkage
- Bond

At paver Design / at paver At paver Design Design QC QC AA AA AA

How Much?

- Design inputs
- Historical
- Based on lab data
- Extrapolated from field experience
- Guess...
- Tolerances
- Action limits / Stop limits

- CTE
 - Why? Design input
 When? Design
 How? AASHTO T 336
 Limits? As per design
 What else Should be done before structural design

Shrinkage
Why? – Influences cracking
When? – Design
How? – Ring, Bar
Limits? – 500 με
What else – ASTM C157 takes months.

- Air
 - ≻Why? Cold weather
 - When? Behind the paver or calibrate loss
 - ≻How? SAM
 - ≻Limits? Ask Tyler
 - >What else do warm places need this?

- w/cm
 - >Why? Controls properties
 - ➤When? At delivery
 - ≻How? Microwave
 - ≻Limits? 0.4
 - What else what about aggregate moisture?

≻Is there a better way?

- Strength
 - ➤Why? Fatigue resistance
 - ➤When? At delivery
 - ≻How? Cylinder, maturity
 - Limits? From design
 - ➤What else Familiar

- Resistivity
 - >Why? Indicates permeability
 - ➤When? At delivery
 - ≻How? Wenner
 - >Limits? 27 kΩ.cm at 28 days
 - ➤What else 28 days

 Workability > Why? – Can we build it ≻When? – At delivery ≻How? – Slump, other?? Limits? – Monitor variability > What else – Need a test to report response to vibration \succ Vkelly, The Box

Unit weight
>Why? – uniformity
>When? – At delivery
>How? – weigh a bucket
>Limits? – watch for change
>What else –

- Setting
 - ➤Why? Sawing window
 - ≻When? At delivery
 - ≻How? UPV, Thermal
 - Limits? none
 - What else use to predict sawing, observe incompatibility

Binder Chemistry
Why? – Affects all performance
When? – At delivery
How? – ???
Limits? – none
What else – "Mixture Verification"

Where Next?

- Prepare a revised Guide Spec
- Build test sections
 - ➤Collect data
 - Monitor performance
- Demonstrations
 - Risk to owner and contractor
 - Constructability
 - > Durability
 - ➤Cost benefit

Where Next?

- Tests still needed
 - ≻Shrinkage
 - >Aggregate issues
 - Freeze thaw / scaling
 - Automated batch reporting in a central plant / dump truck system
- Precision / Statistics
- Mitigate poor materials
- Innovative Materials
- Better mixtures

Where next?

- Educate
 Everyone
- Broaden scope
 Foundations
 Workmanship
 "Change of ownership"
 Maintenance